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CANDID CHAT

Reflections of a "Comeback"

I AM GLAD to have a job again and want to say a few words to my friends, the boys who read *Power* every week and who are striving to make good in every possible way. It is only a few weeks ago that I was going along feeling pretty "kippy" in the old job and had my eye on the pilot house of the station, feeling sure that when Johnson resigned, as I knew he intended, I would be the next chief sure as shootin'.

Johnson did get through; but you could have knocked me down with a feather when the "Super" called me into his office the next day and introduced me to a total stranger, who, he said, was going to run the outfit now that Johnson had retired. I shook hands with my new boss and beat it for the washroom and in about ten minutes was back in the "Super's" office with fire in my eye, wanting to know where I was going to come in on this deal. Well, the "Super" was in a conference and I couldn't see him until 11:30, and by that time was so blamed sore that when I did get into the office of the "Big Boss," I told him I'd come to quit and wasn't going to work in any concern that didn't appreciate its employees any more than this one did.

Well, the "Super" waited until I'd had my say and then had his. He said that he knew I had it in me to make an A-1 engineer and that if he were me he would hold on a bit longer and prepare for a bigger job later; but I wouldn't have stayed even if he'd raised my pay, feeling as I did then, and he saw that it was no use to try to keep me. I put it right up to him why he hadn't offered me the chief's job and dared him to tell me then and there if I hadn't made good. He urged me to sleep on my decision to quit and said he would talk with me the next morning, but I said I was going out of that gate at noontime for keeps and defied him to show wherein I wasn't equal to handling that plant as its chief engineer, and thought I would make him "eat his words."

Well, he was mighty good about it, as I see it now, but believe me, it stung at the time. He told me that the concern never would have gone outside for a new chief if I hadn't treated my job like one in a bank, absolutely confining my interest in the work to the hours of my shift; and that was true. He told me that so far as he had learned, I never had done any outside studying or shown any curiosity about the development of the station; that I was a thoroughly reliable operating man, but that once or twice when he had asked me to write a report when Johnson was away, I had balked at that kind of work and did not even use my imagination enough to see that some big changes were in prospect in equipment; that I knew reciprocating engines and pumps, but that I had never even made enough of a study of turbine practice to make it safe to entrust me as chief engineer with that new high-speed unit which is now going in; and that if I had spent less time at the movies evenings and more reading engineering periodicals and books, I would be far better prepared for the next step. He told me that even if Johnson hadn't given me this kind of advice, I ought to have given it to myself and once more urged me to stand by and stay with the old crowd. But I was filled with blind wrath against Fate, as I called it, and walked out of that office with my head in the air.

I'm not going to let on about the people I saw before landing my present job, but when I had cooled down I realized that the "Super" was right. This isn't the time and place for me to tell what I'm going to do, except this: Believe me, I am going to make this job my *profession* and, so far as I have time and strength, intend to study ahead of the game and qualify myself for the future responsibilities that I believe are sure to come to the man who is fit to carry them.

Power Plant of the St. Joseph Lead Co.

BY E. L. BROOME
Steam Engineer, Viele, Blackwell & Buck

Description of a new central power plant serving several mining properties in southeastern Missouri. Among the unusual features of the plant is the handling of the coal and the feed water.

PRIOR to March, 1917, the St. Joseph Lead Co. and its allied companies, operating lead mines and mills in southeastern Missouri, generated their power at three separate points, each situated roughly at the apex of an equilateral triangle whose sides measure about six miles.

At Leadwood, situated at the western apex, there are one 1000-kw. high-pressure turbo-generator and one 1000-kw. mixed-pressure turbo-generator, the latter operating on exhaust steam from several steam-driven compressors and two horizontal noncondensing steam engines. Each turbine is served by a jet condenser with a spray cooling pond for the circulating water.

At Bonne Terre, the northern apex, there are three gas-engine driven, direct-connected generators with a total nominal capacity of 1620 kw., and at Rivermines, the southern apex, there are four gas-engine driven units of a total nominal capacity of 2160 kw. These plants are connected in parallel by tie lines between Rivermines and Leadwood, and Leadwood and Bonne Terre, but with no direct tie between Rivermines and Bonne Terre.

A gradual increase in the electric load, due to changes from steam to electrically driven machinery and the increase of production during the last three years, created a demand for power which rapidly outgrew the existing capacity and necessitated the installation of a new power plant.

The location of the new plant at Rivermines was determined largely by the situation of the center of gravity of the load and by the consideration of railroad facilities, space for coal storage and an available supply of circulating water. Ground was broken early in April, 1916, and in spite of the congested freight situation and manufacturing delays, the first unit was started Mar. 22, 1917, and the second about a week later. While not a record performance, yet in view of the fact that the main equipment orders were placed during March, 1916, it compares well with similar installations even in less active periods.

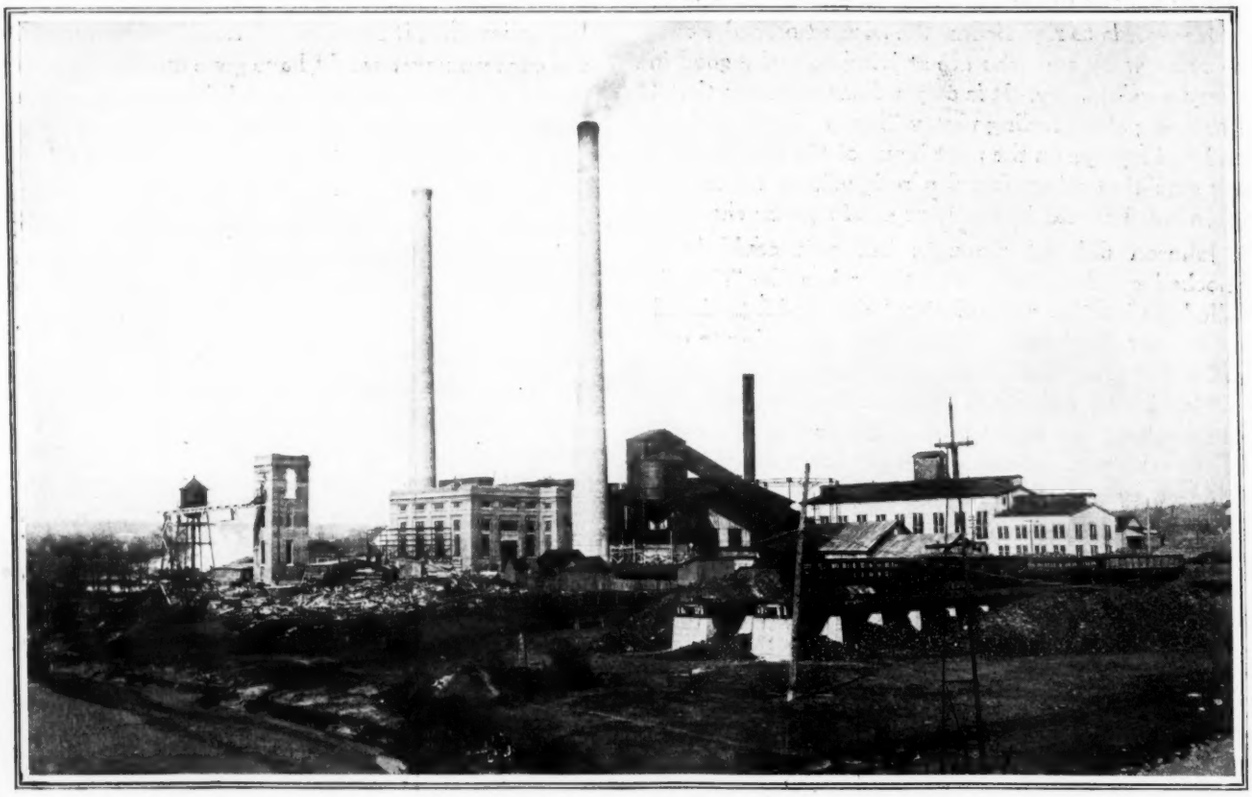

FIG. 1. GENERAL VIEW OF PLANT, SHOWING MAIN BUILDING, COAL BUNKER AND COAL CONVEYOR

In general plan the plant follows pretty well the established practice for an installation of its size, but the unique treatment of several important details justifies a rather extended description.

The foundations are carried down to rock which lies fairly level about 12 ft. below grade. The basement walls of the turbine room and the walls of the cold well are carried down to rock, which is below river-water level; but in the boiler room the columns are carried on piers founded on rock, as are also the main loads of the boilers. Between the piers reinforced-concrete

girders are used, and as the overlay is largely compact hardpan and clay, it was possible to avoid considerable expensive excavation and to pour the girders without forms by trenching to the exact dimensions of the cross-section.

The boiler room is 119 x 43 ft. in the clear and accommodates seven Heine boilers, each of 518 nominal boiler horsepower with superheaters, located above the setting, the superheater flues being built into the side walls of the setting. The stokers are the chain-grate type and have an area of 124 sq.ft. each, or about $\frac{1}{4}$ sq.ft. per boiler horsepower.

Coal is received from an elevated track discharging into a 30-ton steel track hopper underneath, and by means of an opposed pair of reciprocating trough-shaped grizzlies the smaller sizes fall into chutes at each side of the crusher, and thence are fed directly to the belt and the larger pieces roll over the ends of the grizzlies and fall in the center into the crusher hopper, from which they are delivered upon a 20-in. inclined belt conveyor driven from the upper end and provided with a magnetic pulley for the removal of foreign pieces of iron. The belt conveyor discharges into a circular steel bunker 30 ft. in diameter, lined with 4 in. of reinforced concrete and having a capacity of 400 tons. Under the bunker is an 8-ton weighing hopper provided with an automatic registering scale-beam, and discharging into duplicate horizontal helical conveyors 12 in. diameter, extending the full length of the boiler room over the stoker hoppers, the trough being provided with a rack-and-pinion operated sliding gate over each stoker. The solution of the fuel-supply problem is rather unusual and results in a light, well-ventilated boiler room, and the spiral conveyors insure a very homogeneous condition of fuel at the stoker hopper and permit a uniform moistening of the fuel, a practice which the Lead-company operators have adopted to prevent coking and at the same time avoid quantities of dust.

The stokers are driven in the usual way from an overhead lineshaft. Two stoker engines are installed, each of a capacity for driving the whole stoker plant, supported behind the boilers on overhead platforms. The stoker lineshaft is extended at one end through the boiler-room wall, and is provided with an additional drive by an alternating-current motor through reducing gears. The breeching, which is of steel plate, unlined but covered by 2 in. of magnesia, is carried directly upon the boiler settings at the rear, terminating at each end outside the boiler-room wall in a radial-brick chimney 255 ft. high and 9 ft. diameter at the top. As there is considerable surplus mine water, the ashes are disposed of by the launder or flushing method. The water is supplied either directly from the mine-water discharge system or from the outboard circulating-water pipe. The launder troughs, which are lined at the bottom with cast iron, slope each way from the center of the boiler room and meet outside the building in a large concrete sump on the bank of the river. The sump is surmounted by a brick tower in which the ashes and water are elevated by rigid buckets at-

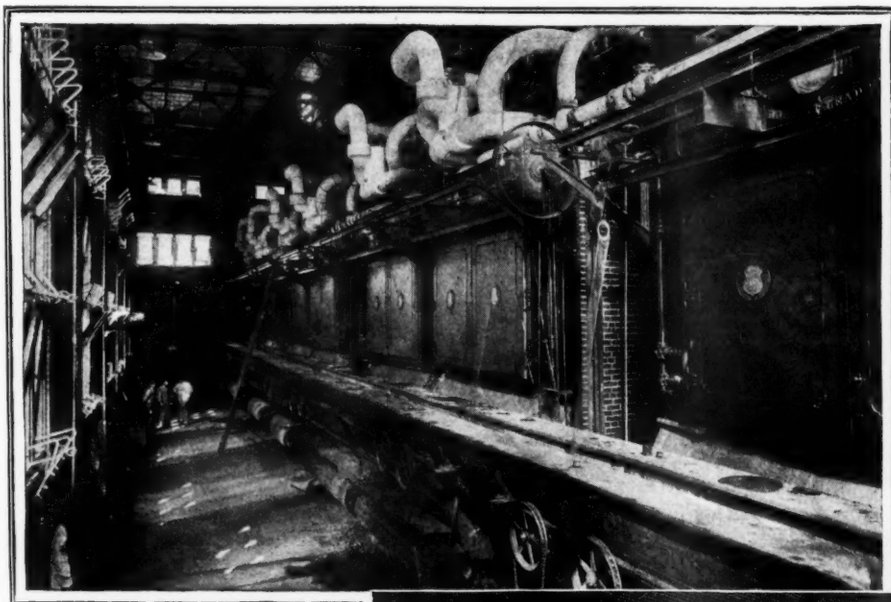

FIG. 2. BOILER ROOM, SHOWING DISTRIBUTING CONVEYOR

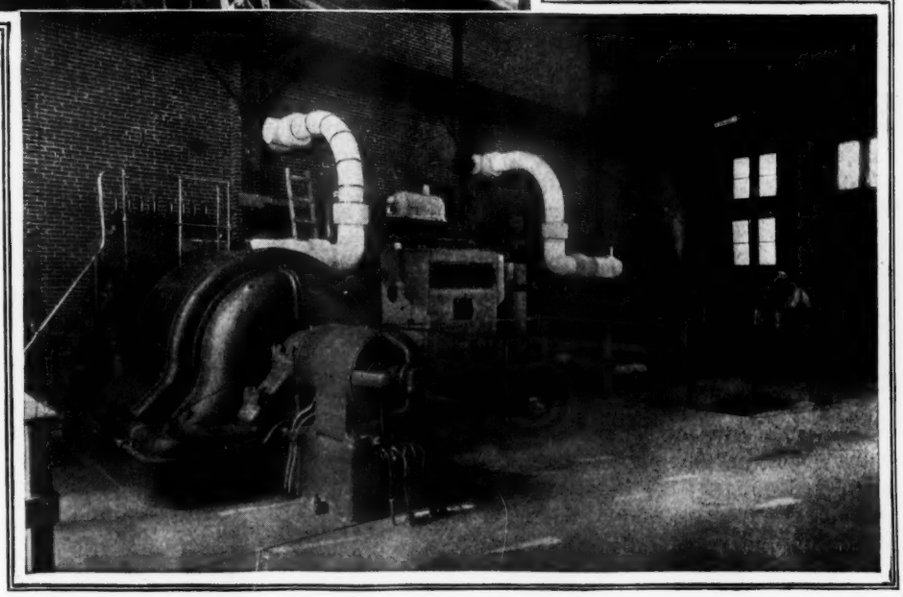

FIG. 3. VIEW OF TURBINE ROOM

tached to two independent rubber belts and discharged at the top into an extended radial trough from which they can be distributed to the flats adjacent to the river.

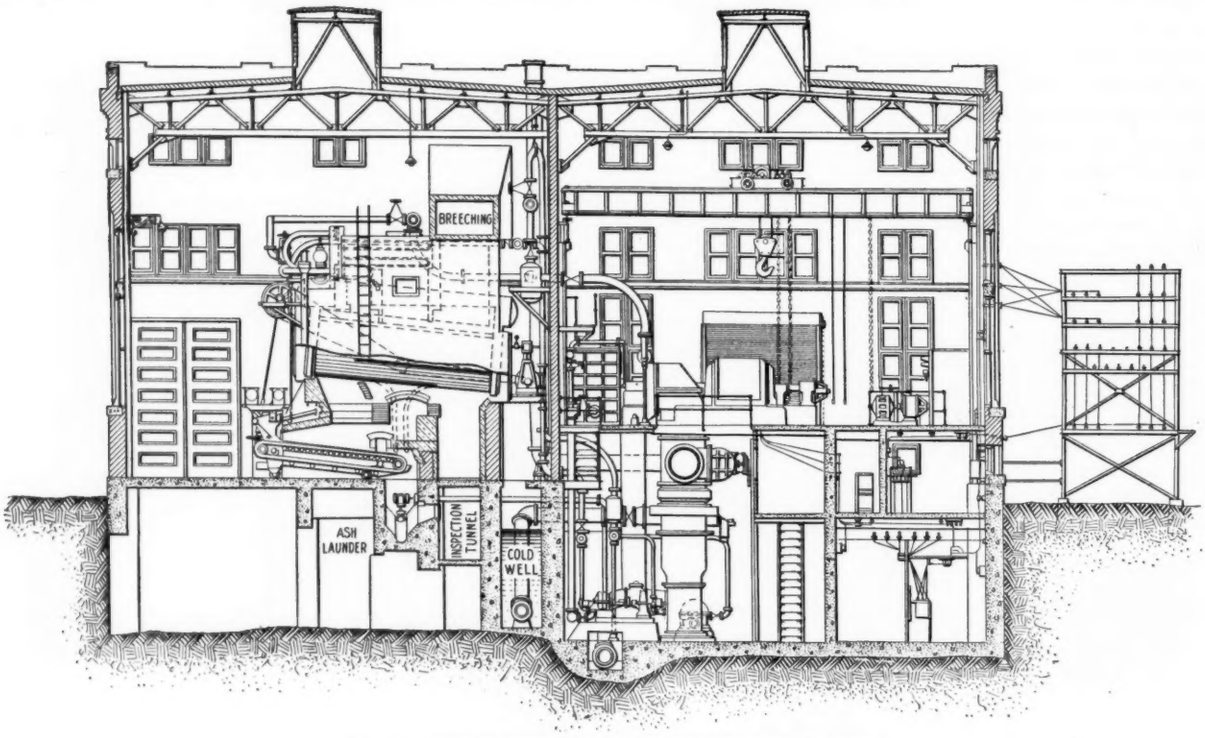

FIG. 4. CROSS-SECTION THROUGH POWER HOUSE

The turbine room is 45 x 72 ft. in the clear, and is served by a 20-ton overhead crane. The racking and trolley movements are hand-operated, and the hoist motor is operated with control from the floor.

There are two 3000-kw. Curtis turbo-generators, with direct-connected exciter, each served by a LeBlanc jet condenser located in the basement. Circulating water is pumped from a cold well between the boiler- and turbine-room basements, and is discharged through 270 spray nozzles into concrete ponds, having a total surface of 27,600 sq.ft. At the corner of one spray pond an overflow is provided to supply water to the mill. The spray ponds return the circulating water by gravity to the cold well, and at an intermediate point in the return pipe a constant supply of about 1500 gal. per min. of cold, fresh mine water is connected. Each generator is supplied through spray washers with 15,000 cu.ft. of air per minute.

Water for boiler feed is drawn from the mine, and the experience of the company was such as to lead to insistence on the maximum of softening. The mine water runs practically continuously at 18 grains per gallon total hardness, equally divided between carbonates of calcium and magnesia. Two complete water-softening treatments have been installed. The lime-soda treatment of the continuous type takes the raw water at 18 grains per gallon hardness and turns it out at 5 grains per gallon hardness. This lime-soda treated water is then passed through a pressure sand filter into a Permutit softening filter. From the Permutit softeners the water, at zero hardness, is led to the feed-water heater.

The desire for an absolutely continuous supply of softened water for the boilers led to duplication of pumps and to an arrangement of piping which would allow great flexibility in operation, of which the following are some of the features:

1. Raw water is normally drawn from the mine sump, but may be drawn from the spray pond.

2. Water softened by the lime-soda process may be taken directly into the feed-water heater, or into the

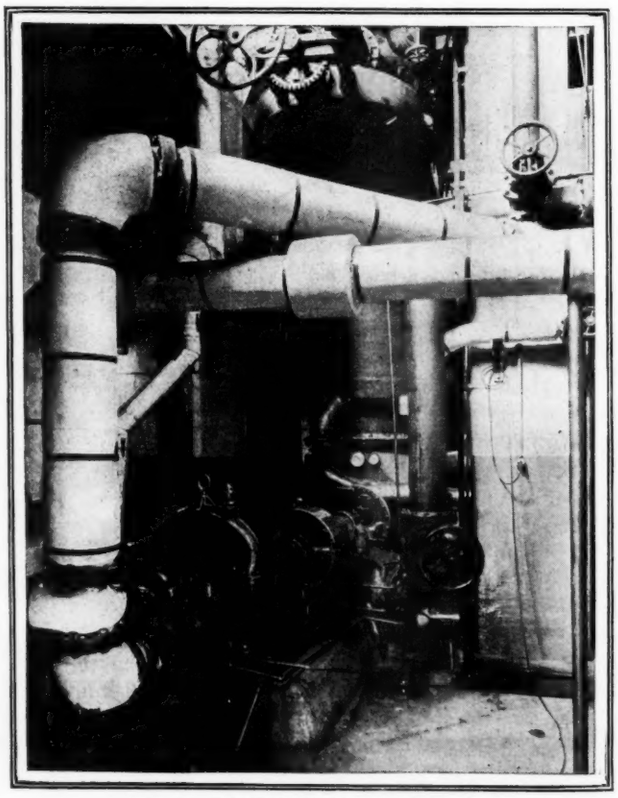

FIG. 5. CONDENSING EQUIPMENT

12,000-gal. steel standpipe which floats on the feed water-supply line.

3. The raw water may be taken directly through the Permutit plant and thence into the standpipe or feed-water heater.

4. Water may be passed through both plants.

5. In case of emergency, raw water may be sent directly to the standpipe or feed-water heater.

The use of separators as junction boxes is a novelty permitting the most elemental simplicity consistent with reliability in the arrangement of the main steam piping. From the outlet of Foster automatic stop valves each boiler is connected by easy bends to group piping, each group discharging into the side of one of two receiver separators, and from each separator the turbine connection is led direct, the two separators being connected together at their top outlets with an 8-in. loop, at about the center of which the auxiliary steam connection is tapped off.

The boiler-feed piping follows the usual lines, but between the pump-discharge header in the turbine-room basement and the header overhead in the boiler room, there are two independent vertical connections, each containing a venturi-meter tube, each tube connected by capillary pipes to a recording and integrating board in the turbine room, so arranged that either tube may be connected separately to the recorder.

The auxiliaries are steam-driven, with the exception of one motor-driven feed pump. The auxiliary exhaust is discharged to an open Cochrane heater. A so-called "constant-pressure" valve is connected to each turbine to discharge surplus auxiliary steam into the low-pressure stage. In order to prevent overspeed from the auxiliary steam supply when the automatic throttle trip operates, a pipe to connect to the under side of the operating piston of the constant-pressure valve is led to the front of the turbine and there automatically opened to the atmosphere by a tripping device operated by the drop of the main throttle.

The electrical equipment consists of the two 3000-kw. generators, with direct-connected exciters, a motor-generator exciter set and station transformers. The current is three-phase alternating 60-cycle, generated at 6600 volts and distributed at the same voltage. The switching system consists of duplicate busses with remote-controlled solenoid-operated oil switches mounted on pipe framework. The feeder circuits are equipped with three-phase aluminum-cell lightning arresters.

The whole installation was designed and constructed by Viele, Blackwell & Buck, engineers, of New York City.

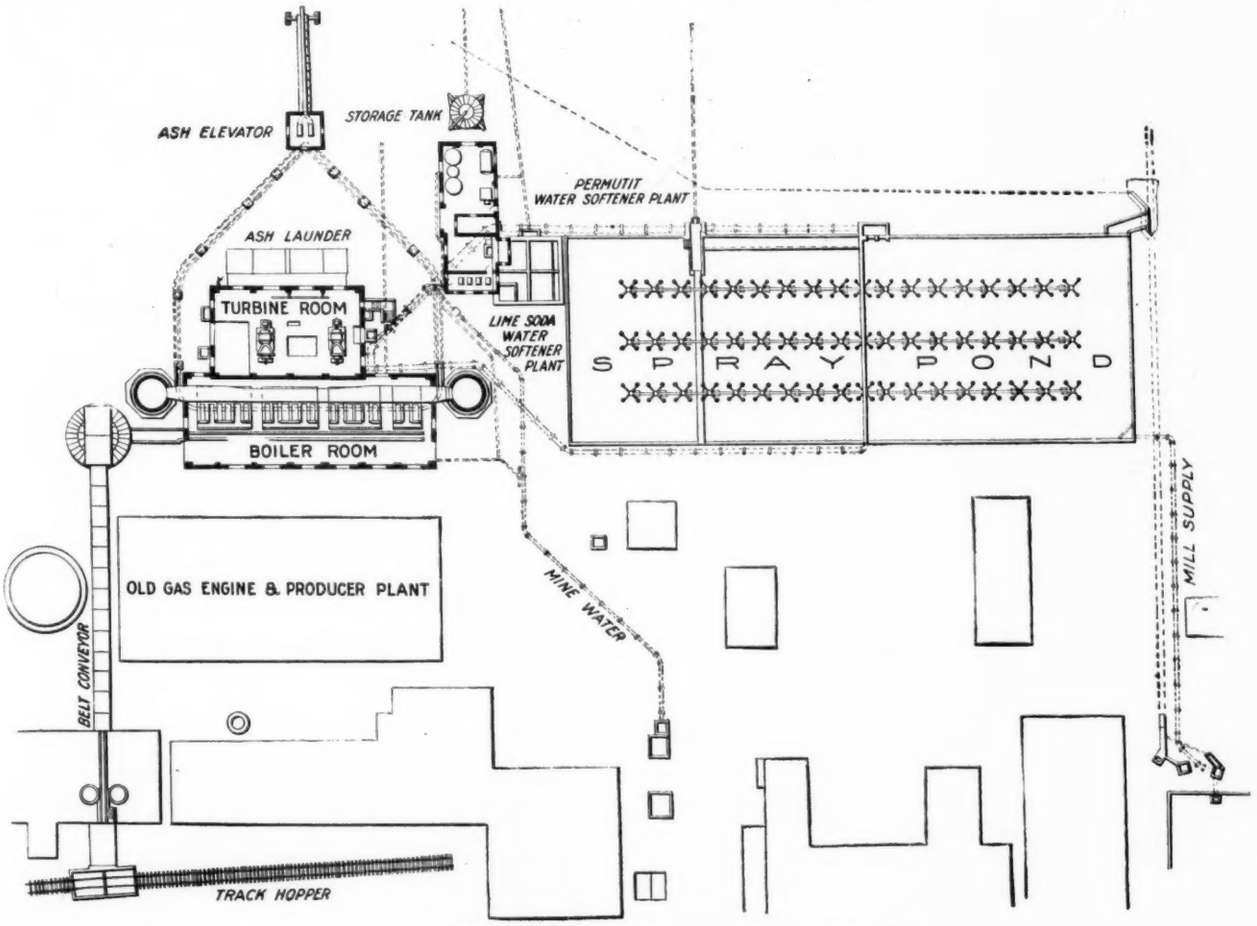

FIG. 6. SHOWING LAYOUT OF ENTIRE POWER PLANT

In recent discussion of electrolytic corrosion of steel before the Iron and Steel Institute, it was brought out that, "Water containing carbonic dioxide is electrolytic at adjacent anodic and cathodic areas in a steel surface. These areas may be revealed by use of an indicator of phenolphthalein and potassium ferricyanide. Where iron dissolves, a blue, and at cathodic spots, a pink reaction is obtained." The quotation is from a letter in London *Engineering*.

Frequency-Changer Sets—II

By QUENTIN GRAHAM
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The capacities of frequency-changer sets used to tie two power systems together and the effects of varying the field excitation of the sets are discussed, after which the construction, operation, application and characteristics of the induction-type of frequency changer are considered. Other types of frequency changers are touched upon.

ONE of the first points to consider in connection with the application of a synchronous frequency-changer set used to connect two generating stations is the size or capacity of the set in comparison with the capacities of the stations. As has been pointed out, the load handled by the set depends on the amount of the load on each system and on the regulation characteristics of each station. Furthermore, a great deal depends on the amount of attention the stations receive. By starting up additional units as the load of one system increases or by adjusting the units already in service, the operator may control the amount of load which is transferred by means of the set. When left to itself, however, the set may be overloaded unless it is of fairly large capacity. No definite statement can be made as to the proper relation between the capacity of the frequency changer and the capacity of either of the generating stations for all cases. The determination of the proper capacity for any particular case must be based on a consideration of all the factors that affect the load carried by the set. The capacity of each station, the regulation of the different units, the load schedule of each station and the watchfulness of the operator all affect the maximum possible load of the frequency-changer set.

Excitation of Frequency-Changer Set

Nothing has been said so far about the excitation of the two machines of the set. Considering the motor first, for each load there is a certain value of field current which gives the most economical operation of the motor itself. However, this value of field current is not always used. As is well known, the power factor of a synchronous motor can be changed by varying the field excitation; or, expressed in another way, the amount of line current drawn by the motor for a fixed load can be increased or decreased by changing the excitation. The curves, Fig. 5, show the effect of varying the field current. With a certain field current the power factor becomes 100 per cent. and the line current is a minimum. Consequently the heating of the armature and losses due to the current are also at a minimum, and the motor is operating under the most economical conditions. However, by increasing the excitation and causing the motor to operate at a leading power factor, thus causing it to draw more line current, there is sometimes a certain advantage gained which more than balances the disadvantage of increased losses and heating in the motor. The advantage referred to is that of raising the power factor of the entire load of the power plant that supplies the motor. A full explanation of just how this is brought about cannot be given here. It may be said, however, that the result of raising the power factor of the load supplied by the plant is that the generators have to supply less current to the line and that they require less excitation. In other words, overexcitation of the synchronous motor places an additional burden on the motor itself, but helps out the power-plant generators. Whether such a procedure is economical on the whole depends entirely upon the design of the particular machines involved and upon the entire layout of the system. The fact that the synchronous motor may be used for power-factor correction if it is desired is one of the favorable points of the synchronous set.

The excitation of the generator end of the set presents a somewhat similar problem, if there are other generators in parallel with it. Of course, if it is supplying a separate circuit, then there is but one value of field current for each load, which will keep the voltage at the proper value. However, when the generator end is in parallel with the generators of another plant the field current may be varied over a considerable range for each different energy load that the set transfers from one system to the other. An increase in field current causes the generator to take an increased share of the load, thereby relieving the other generators in parallel with it of a part of their load. As a consequence the excitation of the other generators can be

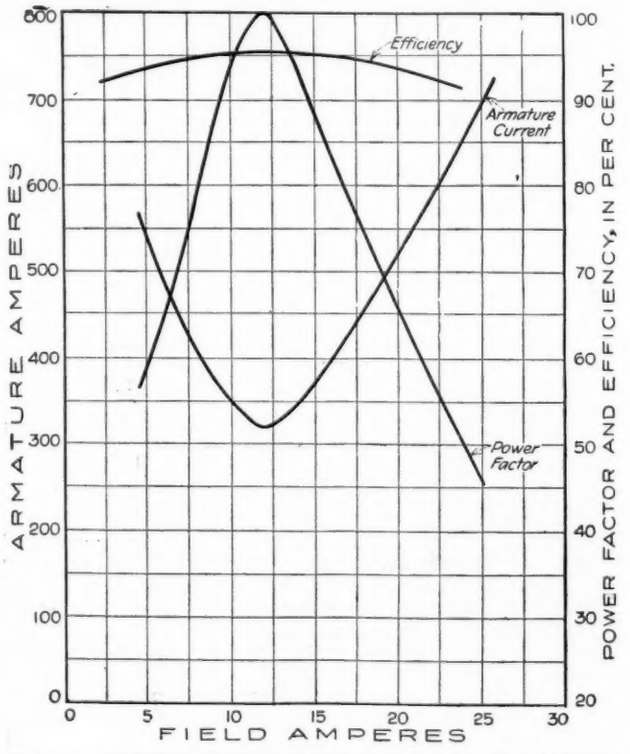

FIG. 5. CURVES SHOWING THE EFFECTS OF VARYING THE EXCITATION ON A SYNCHRONOUS MOTOR

reduced. As was previously stated in connection with the synchronous motor, an increase in excitation of one machine allows a reduction in excitation of the other machines in parallel with it. At the same time the overexcited machine carries an increased armature current. This increased armature current means that the generator's kilovolt-ampere load is greater, although its kilowatt or energy load remains the same. It has been pointed out that the energy that is transferred by the set is dependent upon the prime movers of the two stations.

The foregoing statements cover the case of one frequency changer operating between two generating stations. If there are two or more frequency changers in parallel on both ends and operating in a similar manner, some of the statements made must be modified to some extent. This, however, is a broad subject in itself and will not be considered here.

The induction set, Fig. 6, consisting of an induction motor driving a synchronous generator, has been used to a considerable extent, particularly in the smaller sizes. It usually happens that a small induction motor costs less than a synchronous motor of the same rating and for this reason the induction set is sometimes preferred. In the larger sizes the reverse is true; the synchronous motor is usually cheaper than an induction motor having the same output. Aside from the matter of cost there are certain operating features of the induction set which are different from those of the synchronous set and which must be taken into account when choosing the proper type for a given installation.

One of the main differences between the synchronous set and the induction set is that, with the induction set,

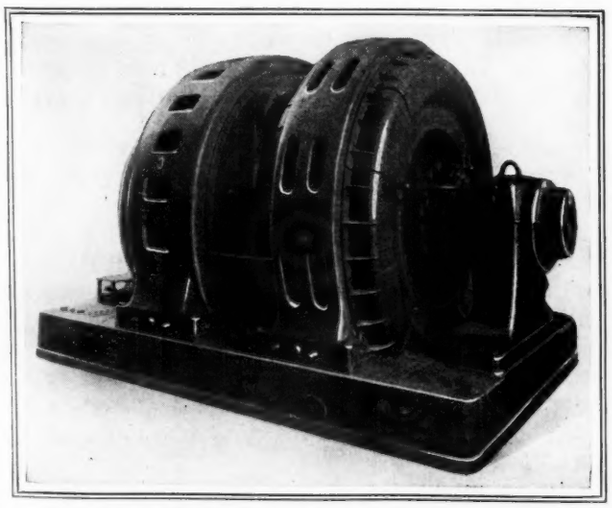

FIG. 6. INDUCTION FREQUENCY-CHANGER SET

the ratio between the two frequencies is not constant, but varies with the load. An induction motor runs at a speed slightly lower than its synchronous speed; that is, the speed at which a synchronous motor having the same number of poles operates. This slight decrease in speed of the induction motor changes with the load so that at full load its speed, and consequently the frequency of the generator which it is driving, may be 3 or 4 per cent. lower than at no load. For ordinary service this variation is not objectionable. The number of poles of each machine may be chosen so as to give the desired ratio of frequencies at full load. For instance, on a set that changes from 25 cycles to 60 cycles the usual arrangement of poles is four on the 25-cycle machine and ten on the 60-cycle machine. At no load this set would run at almost 750 r.p.m., which would give 62.5 cycles on the generator. At full load with a slip, or speed decrease, of 4 per cent., which is a reasonable amount, the speed would become 720 r.p.m. and the frequency of the 10-pole machine would be 60 cycles.

The induction motor for an induction set may have either a squirrel-cage secondary, Fig. 7, or a phase-

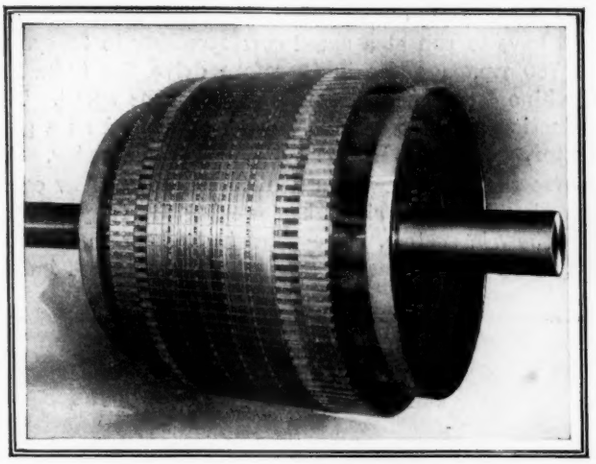

FIG. 7. SQUIRREL-CAGE TYPE ROTOR

wound secondary, Fig. 8. A motor having the latter possesses some advantages which the squirrel-cage motor does not. By using a controller that varies the resistance in the rotor circuit of a wound-rotor motor, it can be made to operate at different speeds while carrying the same load. By this means it is possible to vary the frequency of the synchronous machine that it drives. Furthermore, if the set is used as a coupling between two systems, this means may be used to control the amount of load transferred by the set. If the motor is given a tendency to run faster or slower, it increases or decreases its load until a stable condition is obtained. Changing the secondary resistance of the motor has the same effect as making a governor adjustment on a prime mover; namely, causes a change in the speed of the machine.

The induction set is capable of transferring power in both directions the same as the synchronous set. When the direction of the flow of power is reversed, the generator becomes a synchronous motor and the motor acts as an induction generator. The change in the direction of the power flow is entirely automatic as far as the set is concerned. It is only necessary for the system to which the synchronous machine is connected to have its frequency increased or else the frequency of the other system decreased. In other words, it is dependent on the prime-mover adjustment as in all parallel operation problems. Going more into detail, the induction machine when operating as a generator must be driven above its synchronous speed. It must be driven as much above its synchronous speed when acting as a generator as it runs below that speed when operating as a motor, the same load being considered in both cases. This means that for a reversal of power

the frequencies of the two systems are not in the same ratio as when the induction machine acts as a motor.

For example, the 25-cycle to 60-cycle set previously referred to operates at 720 r.p.m. when delivering full load from the 25-cycle to the 60-cycle system. Under this condition the induction motor has a slip of 4 per cent. Now suppose the frequency of the 60-cycle system is raised to 62.5 cycles. The set is then operating at 750 r.p.m., which is the no-load speed of the induction motor when operating on 25 cycles. In other words, the set does not carry load. Further, assume the frequency on the 60-cycle system is raised up to 65 cycles. It is obvious that the synchronous machine will have to run at a speed corresponding to 65 cycles, or 780 r.p.m., and will therefore drive the induction machine 4 per cent. above its synchronous speed. The induction machine will then deliver full load as a generator, being driven by the synchronous motor. Of course the same condition of reversed power flow could have been brought about by lowering the frequency of the 25-cycle system. The point to be kept in mind is that even though the reversal of power with an induction set is brought about by the same means as with a synchronous set—by prime-mover adjustment—yet in the one case there is a difference in the ratio between the frequencies, while in the other the ratio between frequencies is always the same.

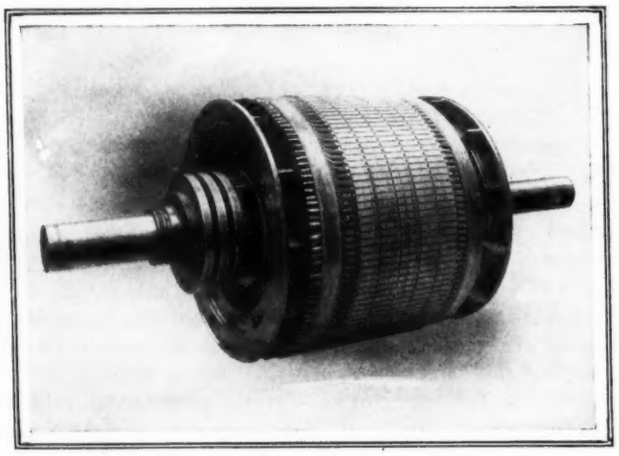

FIG. 8. PHASE-WOUND TYPE ROTOR

One thing in connection with the reversal of power that has not been mentioned is that the induction machine cannot act as a generator unless there are synchronous machines, either motors or generators, operating on the same system. That is, if the 25-cycle power plant were to be shut down, it would not be possible for the induction machine to act as a generator and supply the whole 25-cycle load unless there happened to be some synchronous motors on the line. The flux of an induction machine is set up, not by a direct-current field winding as in a synchronous or direct-current machine, but by wattless current which it receives from the line. There must be a synchronous machine of some sort on the line in order to supply this wattless current. This, of course, applies to the induction motor as ordinarily used and does not take into account the use of phase advancers or other special means of furnishing excitation.

Due to the fact that there must be an actual change of frequency on one system before there can be an interchange of power, the induction set is not so liable to be overloaded and pulled out as is the synchronous set. If a sudden load is applied to one of two systems coupled together through an induction set, the prime movers of that system slow down slightly until they are able to carry the additional load. The slowing down of the prime movers causes a small part of the load to be supplied by the other station through the induction set. If, however, there is a synchronous set in place of the induction set, there can be no change in speed of the one set of prime movers without the same change in the speed of the prime movers of the other station. Since a change in prime-mover speed is brought about by a change in load, it follows that each station has practically the same percentage increase in load. This means that the set has to handle more power than it would if the one group of prime movers could drop in speed without causing the other group to drop the same amount. The induction set permits this and is therefore not so readily affected by sudden changes in the load conditions of either system. For this reason the induction set is often preferred for installations in which the loads are rapidly changing and in which constant attendance is not possible.

Comparison of Frequency-Changer Sets

In comparing the two classes of frequency-changer sets that have been described, there are several points to be considered. It cannot be said that either type is preferable in all cases. It is, however, true that in most installations one set would answer the purpose as well as the other. The determination of the proper type in any particular case must be based on the relative importance of the different characteristics of each type of machine. The following summary will help to emphasize the advantages and disadvantages of both types of sets.

Frequency Ratio: The frequency ratio is constant with the synchronous set, but variable with the induction set.

Reversibility: Both sets can transfer power in either direction, although with the induction set there must always be some synchronous machinery in parallel with the induction motor.

Power Factor: When the synchronous set is used, the motor end may be operated at 100 per cent. power factor or may even be used to correct the power factor of the line. This is one of the chief advantages of the synchronous set.

Starting and Synchronizing: There is very little difference between the two types. A self-started synchronous motor usually takes more starting current than an equivalent induction motor, but in most cases this can be kept within reasonable limits.

Cost: In small sizes the induction set is usually the cheaper, while in large sizes the reverse is more often true.

Overloading: As a general rule the synchronous set is more easily overloaded than the induction set, if used as a tie between two systems. For this reason a larger machine may be required if the synchronous set is used. Overloading may be avoided in either case by proper attention.

While frequency changing is usually accomplished by means of either one or the other of the machines that have been described, there are a number of other ways that can be used. For example, it would be possible to use a rotary converter to furnish direct-current power and then to convert that into alternating-current power of a different frequency by means of a direct-current motor-generator set or an inverted rotary converter. Such an arrangement requires several pieces of apparatus, and although it has been used, it is practicable only in special cases. One direct means of changing frequency is by supplying current of one frequency to the primary of an induction motor and taking current of another frequency from the secondary winding. By driving the rotor at different speeds, the ratio between the frequencies can be changed. Another type of frequency changer consists of a stationary part similar to that of an ordinary induction motor and a rotating part similar to a rotary-converter armature. Voltage at one frequency is applied to the stator terminals and also to the commutator. The armature rotates at different speeds depending on the value of the voltage applied to the commutator, and for each speed there is a corresponding frequency available at the slip rings. There is one frequency changer that consists of a certain combination of static transformers and has no rotating parts. This, as well as some of the other types, has had no extensive use commercially. Several other schemes might be mentioned which, while they may be useful in laboratory work or in some special applications, are not practicable for ordinary service. The two types of motor-generator sets that have been described are the only machines used extensively as frequency changers.

Hot-Water Heating Under Forced Circulation—IV*

By CHARLES D. ALLAN
Consulting Engineer for the Mechanical Equipment of Buildings, Chicago

A typical system of hot-water heating serving five buildings. Full data such as friction head and sizes of pipes and mains are given for the circuit and the individual buildings.

FIG. 1 shows five buildings connected to a system of distributing mains from a central station. Buildings *A* and *B* are each shown twice, but attached to the main line at different points. Figs. 2, 3 and 4 show the continuation of the piping system in the interior of each building. In these diagrams the friction head in feet H_F is either 1, 3 or 3½ throughout. It is assumed that 200 B.t.u. per hour will be given off for each square foot of radiation, and that the temperature drop of the circulating water is 20 deg. An understanding of the diagrams may be facilitated by the accompanying table, showing the maximum square feet of radiation under the conditions given for different sizes of pipe. Having the values of H_F, reference to the logarithmic charts in the second article of this series gave the maximum B.t.u. per hour and division by 200, the square feet of radiation.

All the essential data are given on the diagrams, including square feet of radiation on the basis of 200 B.t.u. per hour per square foot, so that the reading of a cumbersome explanation, with constant reference to letters, may be avoided.

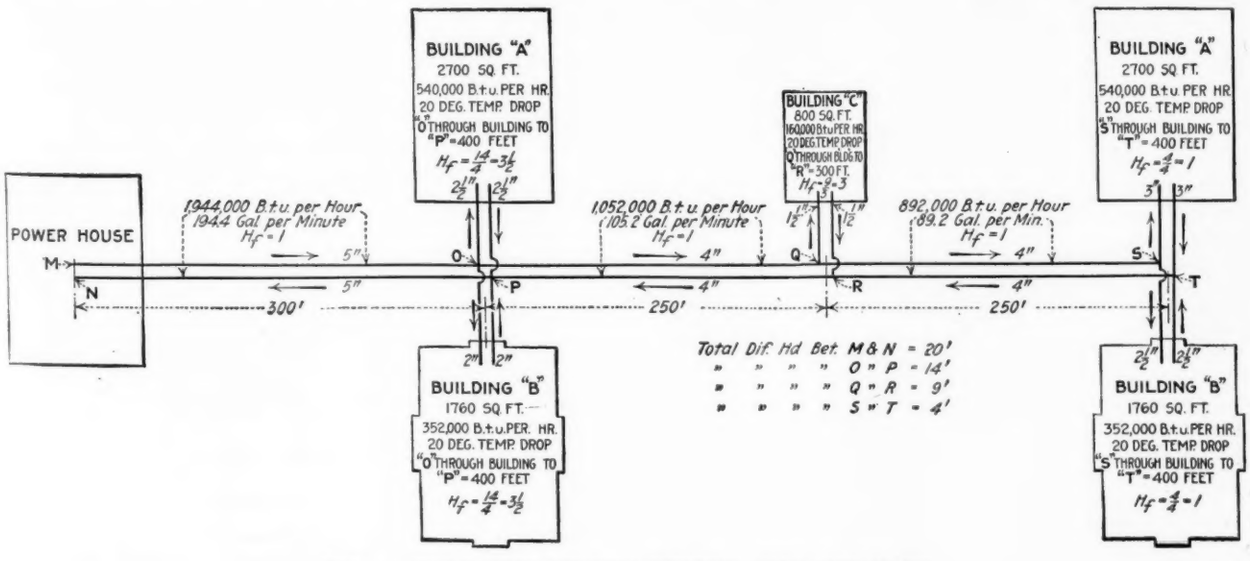

FIG. 1. HOT-WATER CIRCUIT SERVING FIVE BUILDINGS

The entire system is an enlargement of the principles shown in Figs. 1 to 4 of the previous article. Con-

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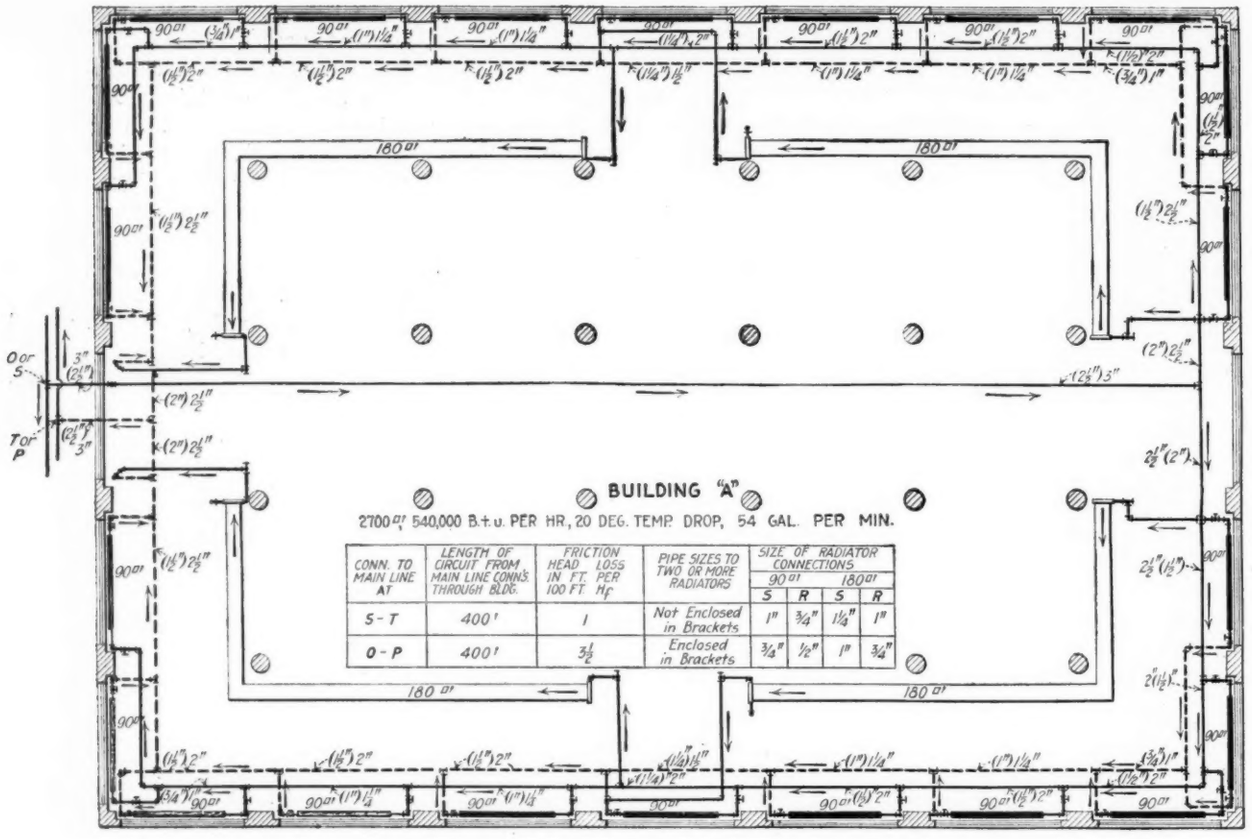

BUILDING "A"
2700 sq ft, 540,000 B.t.u. PER HR, 20 DEG. TEMP. DROP, 54 GAL. PER MIN.
CONN. TO MAIN LINE AT | LENGTH OF CIRCUIT FROM MAIN LINE CONNS. THROUGH BLDG. | FRICTION HEAD LOSS IN FT. PER 100 FT. Hf | PIPE SIZES TO TWO OR MORE RADIATORS | SIZE OF RADIATOR CONNECTIONS 90 sq ft S R | 180 sq ft S R
S - T | 400' | 1 | Not Enclosed in Brackets | 1" ¾" | 1¼" 1"
O - P | 400' | 3½ | Enclosed in Brackets | ¾" ½" | 1" ¾"
O or S
T or P
180 sq ft
90 sq ft

FIG. 2. LAYOUT AND PIPE SIZES FOR BUILDING A

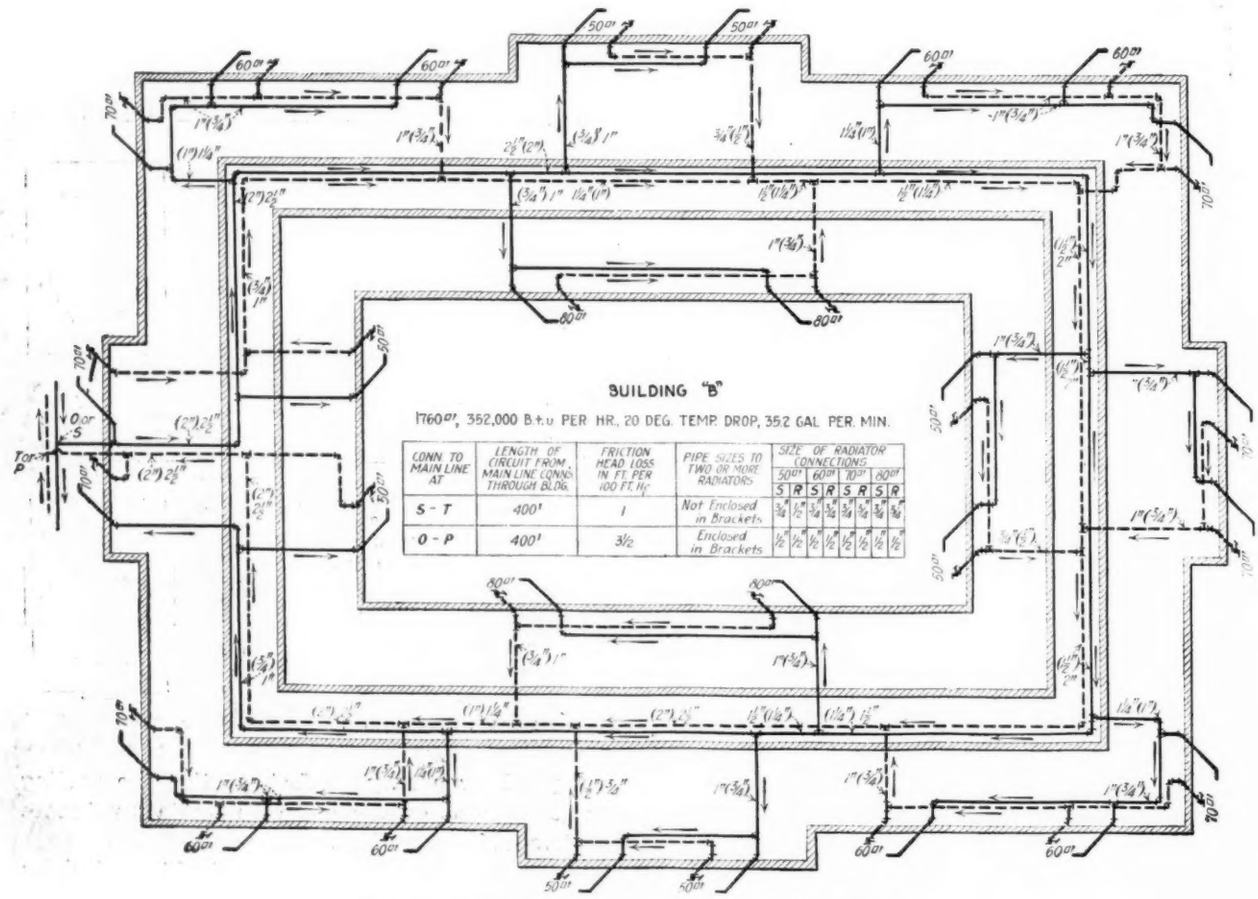

BUILDING "B"
1760 sq ft, 352,000 B.t.u. PER HR, 20 DEG. TEMP. DROP, 35.2 GAL. PER MIN.
CONN. TO MAIN LINE AT | LENGTH OF CIRCUIT FROM MAIN LINE CONNS. THROUGH BLDG. | FRICTION HEAD LOSS IN FT. PER 100 FT. Hf | PIPE SIZES TO TWO OR MORE RADIATORS | SIZE OF RADIATOR CONNECTIONS 50 sq ft S R | 60 sq ft S R | 70 sq ft S R | 80 sq ft S R
S - T | 400' | 1 | Not Enclosed in Brackets | ¾" ½" | ¾" ¾" | ¾" ¾" | ¾" ¾"
O - P | 400' | 3½ | Enclosed in Brackets | ½" ½" | ½" ½" | ½" ½" | ½" ½"
O or S
T or P
50 sq ft
60 sq ft
70 sq ft
80 sq ft

FIG. 3. LAYOUT AND PIPE SIZES FOR BUILDING B

nections between the central station and the individual buildings follow the scheme of Fig. 2. The interior piping is *A* and *B* follows the scheme illustrated in Fig. 1, all circuits through the buildings from the main line

CAPACITY OF PIPE IN SQUARE FEET OF RADIATION SERVED

Size of Pipe, In.	Maximum Square Feet of Radiation HF = 1	HF = 3	HF = 3½
½	38	65	71
¾*	47	85	91
¾	78	137	150
1*	98	175	190
1	145	262	287
1¼	300	550	600
1½	463	825	900
2	900	1,600	1,750
2½	1,450	2,620	2,812
3	2,560	....	....
3½	3,750	....	....
4	5,250	....	....
4½	7,000	....	....
5	9,500	....	....

* Intermediate size.

connections being of equal length. The interior piping in *C* is shunt-connected, as shown in Fig. 4 of the preceding article.

The four diagrams presented herewith comprise a small system of piping that theoretically is as nearly

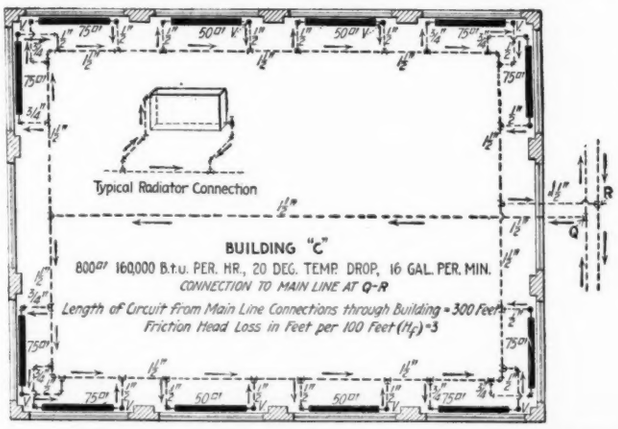

Typical Radiator Connection
BUILDING "C"
800 SQ FT 160,000 B.t.u. PER HR., 20 DEG. TEMP. DROP, 16 GAL. PER MIN.
CONNECTION TO MAIN LINE AT Q-R
Length of Circuit from Main Line Connections through Building = 300 Feet
Friction Head Loss in Feet per 100 Feet (H_f) = 3
R
Q

FIG. 4. BUILDING C RADIATORS ARE SHUNT CONNECTED

correct as the commercial sizes of pipe will permit. The key circuit, 2000 ft. long, passing through buildings *A* and *B* in the position farthest from the central station, has a friction-head loss of 1 ft. per 100 ft., or 20 ft. differential in all at the central station. When buildings *A* and *B* are connected near the central plant, more differential head is available and the pipe sizes inside the buildings can be smaller, as indicated in Figs. 2 and 3, by the numbers inclosed in circles.

An understanding of the diagrams will give all the information essential to a thorough mastery of the principles of design followed in the largest installations of this class of heating, as all such systems are only larger applications of the theory explained.

American Smokeless Stoker

An automatic underfeed coal stoker that differs radically in design from others is being manufactured by the American Smokeless Burner Co., Seattle, Wash. The stoker proper consists of a cast-iron box, Fig. 1, in the center of which is fixed a stationary worm the top of which is pierced with holes to allow the passage of air. Resting on this box and fitting inside it is a circular combustion bowl, Fig. 3, having screw-shaped blades on its lower side, the pitch of these blades being in the opposite direction to that of the planes of the worm.

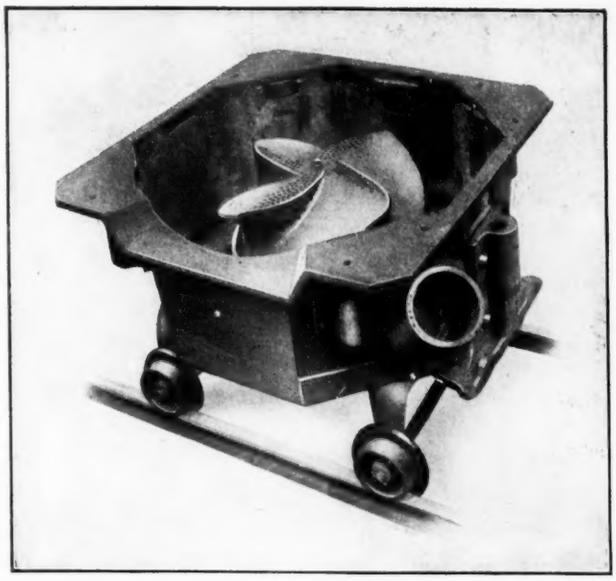


FIG. 1. CAST-IRON STOKER BOX

These blades extend into the bottom of the box and, when the bowl is rotated, serve to raise the coal. The combustion bowl is kept centered by rollers, Fig. 1, and the driving gear, Fig. 4.

The box is kept partly filled with water to prevent the overheating of the working parts and also to serve as a seal to prevent any back blast or leakage of the air supply. This water is dried out of the coal by the heat and draft at a point about two or three inches above the worm feed.

The combustion bowl can be rotated by a system of gearing, in the smaller sizes, the greater portion of

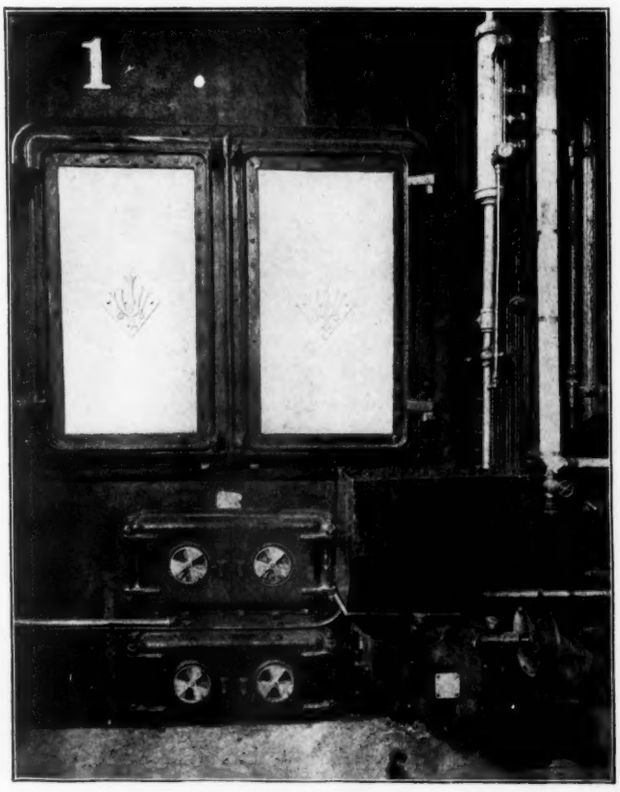


FIG. 2. STOKER ATTACHED TO BOILER FRONT

FIG. 3. CIRCULAR COMBUSTION BOWL

which is inclosed in a box attached to the front of the stoker; in the larger types a worm drive is used. Fig. 4 shows the stoker box and combustion bowl assembled.

Other members of the stoker unit are a small electric motor to drive it, a rotary fan that supplies the draft and a small tank kept supplied with water by means of a float valve.

When the stoker is operating, the coal is fed into the hopper by hand, by gravity or by a conveyor through the side opening, Fig. 4, and passes by gravity into the stoker box, which forms the body of the machine. From this the coal is raised by the blades of the revolving bowl into the stationary bowl, where it is burned, the resultant ash and clinker then passing mechanically upon the brick-covered portion of the furnace, where it gives up its remaining heat, this process being continually repeated. The ashes are removed from the

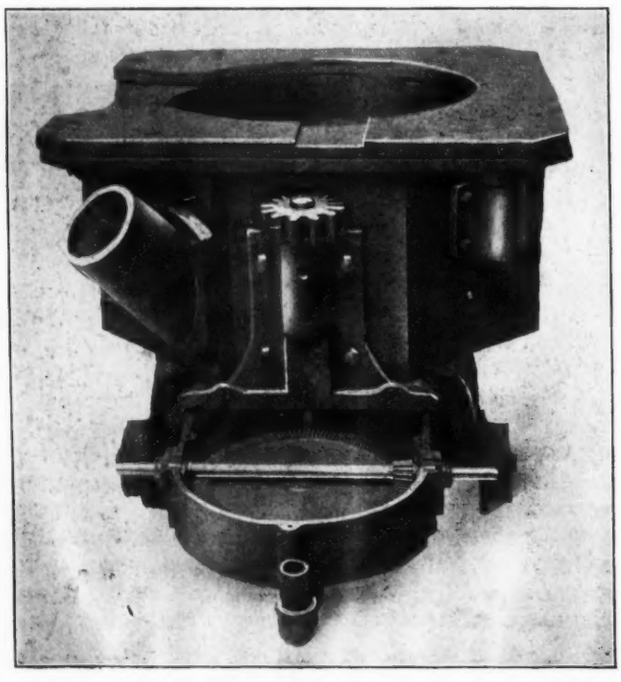


FIG. 4. ASSEMBLED STOKER BOX COMBUSTION BOWL

furnace from time to time as may be convenient. In some of the installations this has to be done only once a day; in the larger ones, more frequently. The stoker of the installation shown in Fig. 2 is placed in the back of the furnace and is surrounded on four sides by a level space floored with firebrick, and outside of this on three sides is also a course of firebrick rising at an angle of 45 deg.; the back section rests against the bridgewall and the sides against the side walls of the boiler setting, Fig. 5.

The driving mechanism is set outside the boiler front on the floor, and a horizontal driveshaft to rotate the bowl and a horizontal worm feed to deliver the coal from the hopper to the stoker are located in the right side of the ashpit and housed in with brick. These are driven by gears and chain and sprocket actuated by the motor that drives the fan. A portion of the grate is left as shown, and the ash and clinker are temporarily delivered here and then removed from time to

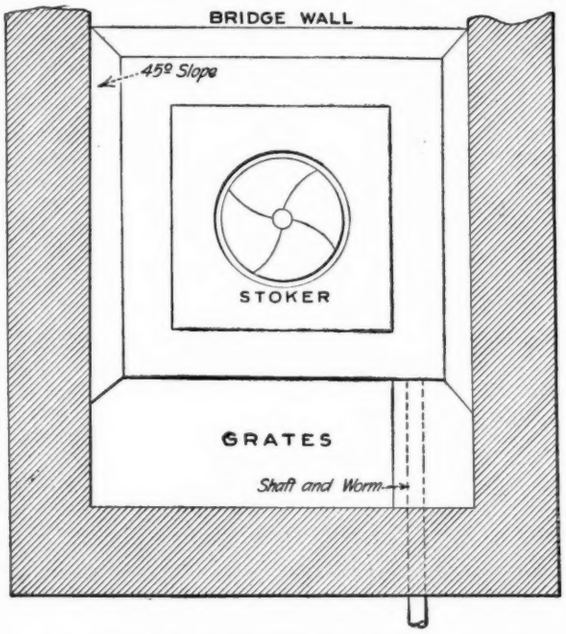


FIG. 5. PLAN OF STOKER BOX AND FURNACE

time by hand until such time as a conveyor system shall be installed.

Three methods are used for controlling the stoker hand control for plants where an attendant is constantly present: The motor is equipped with a three-speed pulley by means of which the attendant changes the rate of the coal feed to suit the character of the load; the second method is by steam-pressure control, by which an electric switch is thrown on or off at certain pressures, changeable at will; the third method is by thermostatic control, in which the switch is operated by the rise or fall of the steam temperature beyond fixed points, also changeable as desired.

The stoker so far has been made in five sizes, the smallest having been used on a 10-in. circular-grade heater. This size burns from a minimum of 2 lb. to a maximum of 15 lb. of coal per hour. The largest size burns 1000 lb. of coal per hour with a minimum of 100 lb. Two of the intermediate sizes will burn from 30 to 250 and from 35 to 500 lb. of coal per hour respectively.

Power Development in Russian Asia

By LUDWIG W. SCHMIDT

Siberia in general is known as the land of desolation and the abode of the Russian exile of the old régime. However, this land possesses many possibilities, as pointed out in the following article, in which the use of machinery for the production and application of power in the various industries in Russian Asia is discussed.

THE Russian hydro-power commission, which some years ago investigated the water-power resources of European Russia intended also to explore the rivers of Siberia. However, only the European section of the work was completed, and no exact data as to the actual water-power resources of Siberia, developed and undeveloped are available. There are a number of powerful streams traversing the Siberia plains, but unfortunately, most of them are not suitable for power development, and they are closed easily by ice. The principal rivers of Siberia freeze during four to six months of the year. While this makes the leading rivers practically useless for power development, there are a number of tributaries which might be used to advantage for water-power plants.

Water Powers Difficult To Utilize

Unfortunately, the utilization of these rivers on a large scale, as the Angara, for instance, and the many waters descending rapidly from the Altai Mountains, is at present economically impossible owing to the lack of sufficient demand for the power created. Another obstacle is the variation in the flow of most Siberian rivers. This variation not only interferes with their use for power development, but is a considerable obstacle to inland navigation and irrigation. It is to be expected that soon after the coming of peace, steps will be taken to remedy the latter difficulty. Before the war a number of far-reaching irrigation projects were under consideration, and it is practically certain that several of these will be completed. The most promising field for irrigation will be the plateau stretching from the Altai Mountains in a northwesterly direction. Here the climate is suitable for agricultural exploitation on a large scale, and several of the leading mining districts are situated in the neighborhood. In the locality probably will also be found the most promising field for hydro-electric development in conjunction with the different irrigation systems.

Notwithstanding these unfavorable conditions, water power is used to a greater extent than might be expected. Especially, mining enterprises have made use of hydro-electric installations. As an example may be given the small but modern installation of the Bogom-Darowanni gold mine in the Government of Yeniseisk. The power house is near the mine, where a Pelton waterwheel is operated under a 500-ft. head. The capacity of the plant is 300 hp., and it cost approximately $20,000 to install. Nearly all the mining districts of Siberia are outside the districts served by the Siberian railroads, consequently it is necessary to keep up the connection between the mines and the railroads by horse-drawn wagons. Most mines in Siberia work with limited profits. To induce a mine owner to install power machinery it will be necessary to give him competent testimony as to probable saving and increase of production. The problems to be faced by the Siberian miner are much different from those dealt with in American mining.

Water Power Used To Drive Mills

Water power is frequently used by flourmills and sawmills. This is especially the case in the eastern parts of Siberia. Most of the mills are still using wooden waterwheels built in Siberia, but the very satisfactory results obtained with modern turbines are beginning to bear fruit, and there is an increasing tendency to import power machinery for installation in new mills. Also several of the older mills have been refitted with modern turbines. Power engineers and mill specialists, in sending catalogs to Siberia, make the great mistake of overestimating the size of the mills of most of their inquirers. Although there are several very large power mills, especially in the Amur and in the Seacoast province, most of the mills in Siberia are of medium size, for which 50- to 75-hp. turbines are the most suitable. It must be added that the milling industry is in the hands of Russians and Siberians and that few foreigners so far have engaged in these enterprises.

What is said as to the employment of water power in flourmills applies also to the sawmills. The proprietors of sawmills have shown themselves to be very progressive, and most of the important sawmills are equipped with electrical installations.

Although there is plenty of coal in Siberia, no great attempt so far has been made to use it for the production of gas for power and lighting purposes. The principal reason for this is that the coal fields are out of immediate reach, and further, electric power is more suitable for the specific Siberian conditions. There seems to be only one gas-works in the whole of Siberia; this belongs to the Technical High School in Tomsk.

Electricity for Street Lighting

The employment of electricity for city lighting on the other hand, made rapid progress in the years before the war and promises to continue. Irkutsk is lighted electrically. The power for the street-lighting system was furnished originally from two private stations, which also supplied power and light to private consumers. In the meantime the city has erected a plant of its own, which originally was planned for 300 arc lamps and 1000 incandescent lamps for street lighting. In general, Irkutsk has proved a good field for electrical enterprise. There are about a dozen smaller installations in the neighborhood of this city, having a capacity of approximately 300 lamps each. The motive power is provided either by steam or by heavy-oil engines. Most of these were of German construction. Other cities having electrical central stations are Omsk, Tomsk, Barnaul and Biisk. The City of Chabarowsk

in the south of the Coast Province has a 350-hp. station. In the Amur province there were in 1913 still no electrical stations of importance, while eight were reported in the Coast Province having a turnover value of $30,900 and 39 men employed. Vladivastock has more than ten private power installations, and in 1912 the city opened its municipal electric station. One year after the beginning of operation, this plant had 1785 subscribers with 32,133 lamps. Further, there was supplied energy for 848 street lamps and 61 motors. It was then contemplated to increase the capacity of the station.

The cities named are all important ones and have active industries which are taking an increasing interest in the use of electric power. In Omsk there are the large repair shops of the Siberian railroad, which are very well equipped, besides sawmills and other industries. Another railroad repair center is in Krassnojarski. Breweries, which are to be found all over Siberia, are also consumers of electric current, and several of them have their own plants and sell their surplus power to neighboring consumers.

A very considerable interest in electric-power development, both for power and light, has been shown by the cement works. One of the most prominent of these in the City of Saigrajewo in the Transbaikalian province, owns a complete electrical installation supplied by a Russian concern. For this installation power is supplied by two 400-hp. locomobiles. During the war there has been an increase in the demand for electric power in most of the industrial cities of Western Siberia where such was available. Under the pressure of the German invasion of Poland the Russian government transferred several of the most important industries of that country to Siberia, where they have added to the industrial importance of the cities in which they were reconstructed, and by doing so have further added to the consumers of the existing power stations.

Other Markets for Electric-Power Machinery

The rapidly growing dairy industry promises to become a very considerable customer for electric-power machinery. This industry is practically entirely in the hands of foreigners, prominently Danes, who come to Siberia with the full understanding of what electricity means in modern dairying. Today there are in the cities many dairies that are using other power than electric as this is still not always obtainable. Steam and internal-combustion engines have been installed.

A considerable market could be created for electrical power in the cities and also in the agricultural and mining districts if it only could be produced cheaply enough. Water power, which generally has been held to be the cheapest source of energy in countries not fully developed industrially, does not hold the immediate promise of success in Siberia, in consequence of the local climatic conditions already referred to. If the small hydro-electric plants in the mines cannot be worked during the winter, there is the consolation that the mines themselves cannot be operated during the winter under present conditions. Therefore there is no need to keep the power stations going. It is, however, certain that more mines will use hydro-electric power as the mining industry grows. The same applies to the agricultural users of hydro-electric power. The installation once made is so superior to any other system of power production that finally it must be adopted in Siberia even with its handicap.

In the cities where permanent power generation is necessary, the use of water power seems to be of less advantage. It has been proposed to combine, where possible, water and internal-combustion engine or steam plants, operating the former during the summer and the latter when the rivers are closed by ice.

Steam and Internal-Combustion Engines

In the electrical stations in operation in Russia today, both steam and internal-combustion motors are used. Both have their individual advantages and disadvantages under Siberian conditions, and it is a matter of locality to decide which promises the best results. Steam generation of power is today still preëminently in use in Siberia, although there are several excellent reasons why in future this should not be the case. The first is that, generally speaking, the water of Siberia, especially in its western parts, is not suitable for steam boilers owing to its very high alkalinity. The second reason is the difficulty of providing sufficient coal. This difficulty exists not so much in the cities, where railroad and shipping facilities guarantee the supply of coal for industrial and private purposes, as in the agricultural districts, where the demand for power of some sort has increased. Even the Siberian railroad has experienced difficulties in supplying coal for its engines, and finally has taken over two coal fields near Tomsk and Irkutsk, from which all coal for the railroad is now sent to the different coaling stations. In cities near the big forests and also in the mining and agricultural districts, where wood can be had cheaply, it is used in preference to coal. Wood for fuel, however, has been increasing in price for several years past, and in the Kirghese steppes farmers owning steam locomobiles have begun to experiment with straw as fuel, which of course necessitates a special arrangement of the firing system of the engines.

In the east the situation as to steam generation seems to move favorably. The larger steam-power mills of Siberia are found in the eastern provinces, and the water conditions are also generally better than in the west.

Size of Engines in Demand

The use of gasoline engines, which has been generally recommended during recent years, has made much progress. Where a limited power development is demanded, these motors have given satisfaction. It is, however doubtful whether their use will be advantageous in power-station work owing to the high price of gasoline. Engineers having studied the situation seem to be very much in favor of the employment of Diesel motors and other motors using heavy oils, which can be obtained at fairly cheap rates from Russian sources. Motors developing 50 to 80 hp. seem to be in demand. It may be added that for agricultural work 14 to 16 horsepower is all that is necessary. Motors of the Diesel type most likely will finally turn out the best for station work, at least for the station of medium size which for a few years may be all that can be expected from Siberia.

The old-fashioned windmill fills a very important place in Siberia. For several years past a number of wind motors of modern construction have been installed, in

connection with mill, irrigation and general farm work. The use of wind motors for the production of electric energy in Siberian villages has been recommended by many engineers who have studied the situation. Before the war a German firm had worked out details of a small combined wind and internal-combustion motor power station for farm work and village power supply. It is likely that a combination of the two might be able to bring electric light and power to places in Siberia which otherwise cannot be supplied.

At present there is little foreign capital employed in power development and electrical enterprises in Siberia. A Belgian concern has shown some interest in this direction, and a well-known German electrical firm has been doing some financing by reason of its Russian connection. Generally speaking, however, such installations as have been made in Siberia are the result of local enterprise. The main reason for the absence of foreign capital seems to be that the projects so far have not been important enough to interest large capital. Under the old régime the apparent insecurity of the investment no doubt has also kept away foreign investors. On the other hand, it seems that the installation of electric power, wherever it has been attempted, has turned out a financial success.

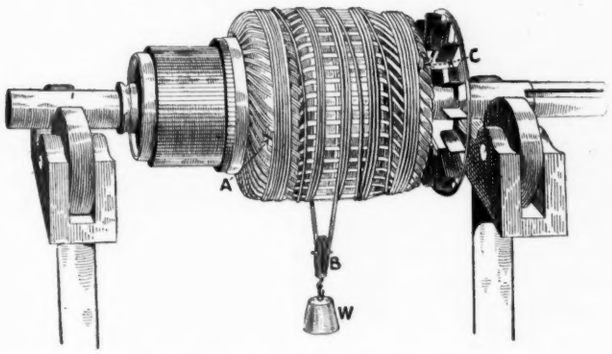
A good deal of ground has still to be broken to make Siberia a really profitable field for the electrical industry and power development in general. The market, however, has shown a rapid improvement during the last few years, and American exporters of power machinery will probably find it to their advantage to look more closely into the opportunities offered by Siberia. The sales policy should lie in the direction of complete equipments for industrial, agricultural and mining purposes and for small city lighting and power supply. The best policy to sell these complete outfits would seem to be to condense the whole offer into a completely worked-out suggestion so that the prospective buyer can see at once what he may expect, what it will cost him, etc. Before the war Germany supplied many of the installations, owing to her special Russian connections. It is doubtful if she will be able to continue doing so after the war.

Method of Banding an Armature

By R. Thistlewhite

The accompanying illustration shows a method of banding armatures that does away with the old scheme of using two pieces of fiber as a clamp or twisting the band of wire around a nail to draw it tight enough, which necessitates the completion of a band when once started and further obviates the removal of a band should it not be sufficiently tight. It will also be found that should the coils project above the core in the banding space, they can be gradually pressed down without driving with a hammer and fiber wedge, thus eliminating one of the frequent causes of short-circuits when the coils are very tight.

To use this method, fasten one end of the banding wire to a coil at one end of the winding at *A* and lay the band on hand tight in one piece, then pass the finishing end of the banding wire through the pulley *B* and fasten it to the winding at the other end of the armature as shown at *C*. Attach a weight *W* to the pulley, according to how tight the band is required, and turn the armature. When the armature is turned, no matter how fast, the banding wire will follow in exactly the same place as it was laid by hand, consequently the band must be placed on in the first place perfectly straight. When the weight has traveled to the other end of the armature, if the bands are not satisfactory,



PLACING BAND ON ARMATURE

turn the armature in the opposite direction and keep repeating the operation until tight enough.

This may be repeated as many times as deemed necessary, and more weight may be added as the process is continued, until sufficient pressure is obtained without breaking the banding wire. On account of being thus able to apply a gradual pressure, the coils can be gradually pressed down into the slot should they be high, with probably the assistance of a very light tapping with hammer and fiber.

Boilers for the Emergency Fleet

Following are particulars about the standard water-tube boilers designed by the Shipping Board for the 3500-ton vessels of the Emergency Fleet.

The boiler is a cross-drum type having straight tubes expanded into steel-plate headers. The width of the boiler is 13 ft. 4⅜ in.; height to center of steam drum, 11 ft. 5½ in.; depth, 8 ft. 10 in. The heating surface, total, is 2544 sq.ft., made up as follows: Tubes, 2452 sq.ft.; front header, 33 sq.ft.; back header, 38 sq.ft.; drum, 21 sq.ft. The tubes, 414 in all, are seamless steel, No. 11 B.w.g. and 3 in. outside diameter. The three bottom rows of tubes are of No. 10 B.w.g. The heads of the steam drum are bumped; one is solid and of ⅝ in. thickness, the other 11/16 in. thick.

The grate is 6 ft. 6 in. long by 11 ft. 11 in. wide; area, 77.45 sq.ft., giving ratio of heating surface to grate area of 33 to 1.

The boilers are made according to the specifications of the United States Steamboat Inspection Service for 200 lb. gage pressure, and output under forced draft of 15,000 lb. of water per hour with feed at 200 deg. F. and combustion rate of 20 lb. coal per sq.ft. grate per hour.

What is probably the world's highest velocity rope drive, according to J. Melville Alison, is in operation in Cleveland, Ohio, where 19 two-inch ropes travel 7800 ft. per min. over a driving sheave 14 ft. 4 in. diameter to a driven sheave 4 ft. 7 in., only 27½ rope-diameters, transmitting about 1400 hp.

Symbols for Mechanics and Hydraulics

BY JOHN T. FAIG*

For about a year a committee of the Society for the Promotion of Engineering Education has been working upon symbols for mechanics and hydraulics in the hope of standardizing practice. Perhaps the following statement of the methods followed, and the results obtained so far, may be of interest.

Letters were sent to professors of mechanics and hydraulics who are members of the society, and to some other persons. Each letter requested the recipient to suggest the symbols that he thought should be standards in mechanics and hydraulics. Eighteen replies were received, of which 13 were accompanied by lists of symbols, 4 favored a standard list but submitted no specific suggestions, 1 opposed standardization of symbols by the committee. The suggestions made in an article in the *Engineering News-Record* of Apr. 12, 1917, by R. Fleming, of the American Bridge Co., were also tabulated. The symbols suggested were charted on a large sheet and tabulated. The list was sent to about 50 professors, editors and engineers, requesting criticisms. Nineteen persons sent replies that contained criticisms and suggestions. The committee also received suggestions from representatives of some of the national engineering societies and from a number of prominent publishers of engineering books.

The editors approved heartily of the idea of a standard list and objected to all Greek letters except π; otherwise they did not care particularly what symbols were selected. This attitude was also that of most of the practicing engineers. Professors went into considerable detail and had strong preferences, but differed widely in their views. Those professors who had had the largest experience in writing and whose works are best known, were favorable to the list. This was exactly contrary to the expectations of the committee.

A majority of the replies approved of a standard list based on the one submitted. In the light of the suggestions received the following list was made.

SYMBOLS APPROVED BY THE COMMITTEE

Concept	Symbol	Concept	Symbol
Acceleration due to gravity	g	Inertia, Polar moment of	J
Acceleration, linear	a	Inertia, Rectangular moment of	I
Area	A	Length	L
Breadth	b	Load, Eccentricity of application of	e
Center of rotation	O	Mass	m
Coefficient of friction	f	Modulus of section	Z
Coefficients and constants	C, K	Modulus of elasticity, Young's	E
Deflection of beam	Y	Quantity of liquid flowing	Q
Depth	d	Radius	r
Diameter	D	Radius of gyration	k
Distance passed over	s	Reactions	R
Distance of extreme fiber from neutral axis	c	Revolutions per unit of time	N
Efficiency (Hydrau., Mech., Vol)	eh, em, ev	Stress, unit	S
Force	F	Time	t
Force, Moment of	M	Torque	T
Head	H	Velocity, angular	w
Height	h	Velocity, linear	v
Horsepower	Hp	Volume	V
Hydraulic radius	Rh	Weight	W

Previous lists of symbols have not secured wide acceptance in this country. Some lists that have been proposed by prominent writers are familiar to very few engineers. It was apparent that the chief difficulty to be overcome was not in the formation of a list of symbols, but in securing the acceptance of the list. The method followed by the committee has been to collect evidence regarding present practice and to present it. The list obtained by this method has disadvantages. The symbols composing it are not of the same order of importance. Many omissions, some of importance, occur. But it is believed to hold the nucleus of a standard list of symbols for this country, because it is composed of symbols that are in general use. Objection has been raised on the point that professors and writers, rather than engineers, have been consulted in its making. But it is the professors and writers who are largely responsible for the present chaotic situation with regard to symbols and it is only by concerted action of these that some order may be brought out of chaos. Engineers and editors appear willing to accept any list that will be accepted generally. The list is presented in the hope that it will assist in the evolution of a standard list. It is short. It contains no Greek letters. It is mnemonic to a considerable degree, though not by intention. It deals largely with mechanics because that branch is common to all the divisions of engineering.

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Legislative Progress of the Boiler Code

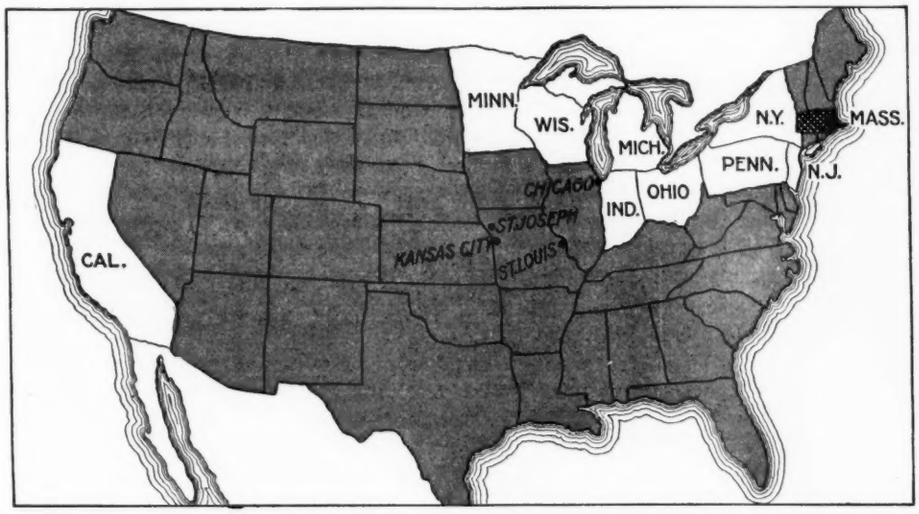
The accompanying map shows the states and cities in the United States that have adopted the Boiler Code of the American Society of Mechanical Engineers. The states that have adopted the Code are in white. *Power* will from time to time, as more states and cities adopt the Code, keep the map up to date. The states having adopted the Code are New York, New Jersey, Pennsylvania, Ohio, California, Indiana, Michigan, Wisconsin and Minnesota. The cities are Kansas City, St. Louis, St. Joseph, Mo., and Chicago. The Boiler Code for New York, through its industrial commission has lately been distributed. The commission has jurisdiction only over industrial establishments and it is to these only that the code will apply for the present. New Jersey passed an enabling act, which was signed by the Governor and the Board of Boiler Rules appointed. The board is made up of the following members: Col. Lewis T. Bryant, Commissioner of Labor, under whom the Boiler Code in New Jersey will be enforced; Franklin Van Winkle, associate editor of *Power;* Frank Casler, superintendent of power plants, Public Service Electric Co. of New Jersey; Joseph Scott, of the Engineer's and Firemen's License Bureau; A. L. Case, and D. Walker, both of the same bureau. That part of the Code relating to new boilers goes into effect Nov. 1 of this year; that for old boilers, with slight modifications, will soon become law. Massachusetts, cross-hatched, has its own rules and has not adopted the Code.

Michigan has adopted the Code, and Governor Sleeper has appointed the following men as members of the Board of Boiler Rules: Prof. G. W. Bissell, East Lansing; E. C. Fisher, Saginaw; John C. McCabe, safety engineer, Detroit; Sheridan Milan, Grand Rapids; and Prof. G. E. Christensen, of the Houghton School of Mines, Houghton. The first meeting of the board was held on Oct. 19 at the State Capitol at Lansing.

It is expected that the adoption of the Code by St. Louis, Kansas City and St. Joseph will influence the Missouri legislature to adopt it as a state-wide law. Minnesota is issuing a notice through the Inspection Board of the state that after Jan. 1, 1918, all boilers must be made in accordance with the Code. The action

has of course been approved by the Governor. Considerable interest has centered in the State of Colorado, where attorneys advised the American Uniform Boiler Law Society that it is not necessary to have a bill passed in the Colorado legislature in order to have the Code adopted by that state, as the new industrial commission will have the power to adopt it.

In a report to the society Thomas E. Durban, chairman of the Administrative Council of the American Uniform Boiler Law Society, said that the society had



STATES (WHITE) AND CITIES THAT HAVE ADOPTED THE A. S. M. E. BOILER CODE

in all cases limited its efforts to get an enabling act through the legislature to create a board to draw rules. They had met with opposition in several states because they refused to participate in the legislation concerning the details of inspection of boilers. Mr. Durban reported that in many states riders calling for the appointment of boilermakers only as inspectors had been attached to enabling acts. These riders have in all cases defeated the enabling act.

Enabling acts were introduced in the States of Washington, Oregon, Texas, Tennessee, Rhode Island, New Hampshire, South Dakota, Iowa, Utah and Kansas. All failed of passage. There is general confidence, however, that the legislatures in these states will at their next meeting pass the necessary enabling acts. Mr. Durban lays great stress upon the influence of publicity in the work of getting the Boiler Code adopted in the several states, saying: "It entailed a great amount of work and the coöperation of many loyal supporters of the Code to get the bills introduced and to secure the publicity which the Code needs in order to get it put into effect. Our campaign has been largely one of education and publicity, and it is our firm belief that publicity will accomplish any legislation of merit, and it is almost impossible to get legislation passed, no matter how meritorious it may be, without the proper kind of publicity. In no state was the Code defeated on its merits. The arguments in its favor have not been successfully met in any state. All agree on the necessity for the Code, and in no state has it been successfully attacked."

The map is interesting because of the industrial importance of the states having adopted the Code compared with states that have not adopted it.

The Care of Portable Electrical Measuring Instruments

By H. C. Yeaton
Meter and Instrument Specialist, Lynn, Mass.

The accuracy and the cost to maintain portable electrical measuring instruments depend to a great extent on their care and the way in which they are handled by the operator or tester, and it would not be exaggeration to say that electrical measuring instruments should receive as much care as a pocket watch if not more. It might be well to remember the following precautions, when handling or using instruments which are essential to obtain correct measurements, as well as to maintain the accuracy of the instruments: The cover or base of an instrument should never be left removed for any length of time, as dust, which may be floating in the air will get into the jewels, causing the moving element to become "sticky." Always lay an instrument down gently, or the fine points of the pivots and the polished surfaces of the jewels may be damaged, which will cause "stickiness."

Arrange the leads from the circuit to the instrument so that there will be no danger of the instrument being pulled on the floor by passing persons or otherwise.

On voltmeters and wattmeters, which have potential contact switches, it is advisable to leave the switch open as much as possible, even though the winding might not be damaged by a continuous current.

High-grade instruments are shielded from stray fields by iron punchings or iron shields, nevertheless it is good practice not to subject the instrument to stray fields if avoidable. Twisting the leads together will eliminate one source of stray fields. Other sources are rheostats, dimmers, reactive coils, circuit-breakers, etc., which might be avoided by placing the instruments a considerable distance away.

Never place instruments nearer iron than necessary, as certain errors may be introduced. Iron tools, bench supports, etc., serve as good examples.

Before connecting an instrument in a circuit, it is advisable to ascertain that the current or potential of the circuit is within the limiting capacity of the instrument, otherwise the current or potential windings may become overheated, causing a "burnout." This caution is particularly applicable to wattmeters when measuring inductive loads, as the current might be excessive when the indicated watts on the scale were low, which is due to low power factor. It is generally advisable when an instrument has more than one capacity, to connect in the highest capacity first, so as not to overload the windings.

It is not good practice to leave a voltmeter or wattmeter connected in a circuit, as the voltage or current of the circuit might be increased in some way or other.

The glass over the dial should never be rubbed while using an instrument, as it may electrify the glass, causing it to attract the pointer, and thereby introduce an error.

When an instrument is going to be used with a shunt or multiplier, the shunt or multiplier should be carefully examined to ascertain that the results will not be in error. In general practice, the shunt or multiplier bears the same serial number as the instruments with which they are going to be used, otherwise it will be necessary to calculate a constant for the scale readings.

Instruments should never be placed where they will be subjected to vibration, whether they are in use or out of use, as the pivots or jewels might become damaged, and cause an error in measurement of the circuit.

It is not advisable to attempt the repair of an instrument, unless the repairer is familiar with repairing instruments and has every facility for doing the work. It usually costs less, in the long run, to return the instrument to the manufacturer, who has skilled instrument makers and every convenience for repairing and recalibrating.

All instruments should be checked often by laboratory standards to determine the accuracy or the necessity of recalibration.

When an instrument is not in use, it should be inclosed in the case or the cover should be closed, and the instrument should then be carefully placed away in a dry, secure place, where it will not become damaged and where it will be free from dust.

If an instrument is received from the manufacturer with instructions for operating, it is advisable to study the instructions carefully, particularly the diagrams of connections, as it is easy to connect the instrument in the circuit incorrectly and obtain wrong results or burn out the windings. The nameplate rating should also be carefully noted before the instrument is connected in the circuit, in order that the instrument will not be subjected to a circuit for which it is not intended.

If occasion arises, where instruments are to be shipped by railroad or otherwise, every precaution should be given to their packing to avoid damage. It would be well to note the way they were packed when received from the manufacturer.

Interpretation of Co_2 in Flue Gas

By R. L. Wales

One of the big losses in the generation of steam is in the chimney gas, and it is twofold, or is the resultant of two separate losses. One is the heat carried up the chimney by the escaping gas and is the heat necessary to raise the temperature of the given amount of outside air to that in the flue. This loss may be enormous. The other is the potential heat passing off in the form of unburned fuel gas. The magnitude of these losses depends on the excess of air sent through the furnace. If the first (the excess air) is large the second may be small. On the other hand, if an attempt is made to minimize the first by restricting the air used, a point is soon reached at which the loss from incomplete combustion more than offsets the saving thus effected. Little excess air means a high per cent. of CO_2 and a large per cent. of CO and other combustible fuel gases, because of the insufficient air supply for complete mixing and combustion. Failure to recognize this second aspect of the problem has led many to overdo the matter of flue-gas control by regulating for maximum CO_2. As might be expected, the results of such attempts have been disappointing and have tended to discredit the whole matter of chimney-gas analysis.

It is evident that between these extremes there lies some best value for the excess of air to be admitted—a value at which the sum of the two losses mentioned is a minimum. Just what this optimum excess is in any case will depend on the chemical and physical properties of the fuel, the ease with which the air can penetrate and mix with it and the size and configuration of the combustion space; or, in other words, upon the chance for a thorough mixing of the combustible gases with the air supplied before the temperature has been so lowered, by contact with the comparatively cold surfaces of the boiler, that combustion is no longer possible.

It is customary to determine roughly the excess air by the per cent. of CO_2 in the flue gases. As a matter of fact the CO_2 is not an immediate measure except in rare cases, but the practice has grown because it is easy to determine the CO_2 and comparatively difficult to determine the real excess air. Assuming complete combustion, the per cent. of CO_2 is, to be sure, an indirect measure of the excess air used; but in even that case it varies for each different kind of fuel. For example, in the case of fuel oil, 8 per cent. CO_2 would

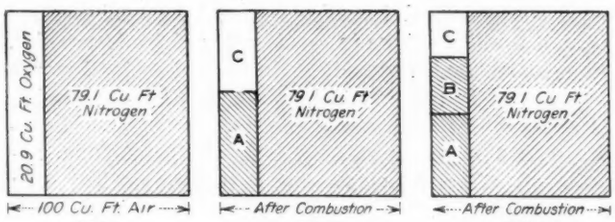


FIG. 1 FIG. 2 FIG. 3

FIGS. 1 TO 3. AIR BEFORE AND AFTER PASSING THROUGH A FURNACE

Fig. 1—Atmospheric air. Fig. 2—Product of incomplete combustion. Fig. 3—Influence of hydrogen

mean about 96 per cent. excess air, while in the case of soft coal it would mean about 125 per cent. excess air.

Let Fig. 1 represent 100 cu.ft. of air entering the furnace, composed of 20.9 cu.ft. of active oxygen available for combustion and 79.1 cu.ft. of nitrogen which takes no part whatever in the process of combustion, but tends to lower the furnace temperature and to rob it of heat.

Fig. 2 represents the same air after it has passed through a furnace in which carbon is the only substance burning—the temperature and pressure have been returned to the original values. In the process of the combustion of carbon, one cubic foot of CO_2 is formed from each cubic foot of oxygen taking part in the combustion, and as the nitrogen and unused oxygen pass through the furnace without change, there will evidently be 100 cu.ft. of gas coming out of the furnace for every 100 cu.ft. entering, if measured at the same temperature and pressure. The only change is that of the 20.9 cu.ft. of oxygen entering; a certain amount, A

in the diagram, has become CO_2 during the combustion. In this case, since 20.9 cu.ft. of oxygen was supplied, while only A cu.ft. was used in the combustion it is evident that the ratio is

$$\frac{Oxygen\ supplied}{Oxygen\ needed} = \frac{20.9}{A}$$

or, since the air and oxygen vary together,

$$\frac{Air\ supplied}{Air\ needed} = \frac{20.9}{A}$$

A would be the number of cubic feet of CO_2 in 100 cu.ft. of the flue gas, or would be the per cent. of CO_2. In this case then, which might be that for a fire of charcoal or coke, the per cent. of CO_2 would be a correct, though indirect, measure of the excess oxygen C, since the sum of the two must always be 20.9. It is evident that for such a case the CO_2 might range from very small values to a theoretical maximum of 20.9 per cent. when the excess air was zero.

In the majority of cases, however, the combustible comprises not only carbon but hydrogen, as represented in Fig. 3. Of the 20.9 cu.ft. of oxygen entering, A represents the cubic feet burned with the carbon to form CO_2, and B the cu.ft. burned with hydrogen to form water. It is apparent that area A is no longer a measure of the oxygen needed, the difference between A and the actual requirement depending on the ratio of carbon and hydrogen in the fuel. If the fuel were 100 per cent. hydrogen, all the oxygen would be required and of course the products of combustion would show no CO_2. Moreover, A would no longer represent the per cent. of CO_2 in the flue gases, for the steam formed by the combustion of the hydrogen with B cu.ft. of oxygen condenses long before the gases are analyzed, thus practically eliminating volume B from the original 100 cu. ft. The CO_2 would analyze then, not A cu.ft. per 100, but A cu.ft. per 100 minus B, or something larger than A per cent. It will be seen that when hydrogen is present in the fuel, the CO_2 could never reach 20.9 per cent. even with no excess air.

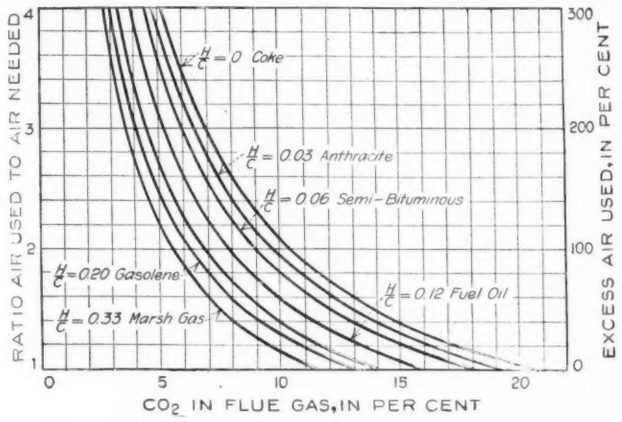


FIG. 4. RATIO OF AIR TO CARBON AND HYDROGEN

The ratio of air admitted to air needed then becomes, not $\frac{20.9}{A}$, but $\frac{20.9}{A+B}$. If the ratio between the hydrogen and the carbon in the fuel is known, then B can be found in terms of A. The per cent. of CO_2 corresponding to A can be calculated, and hence the ratio of air admitted to that needed may be expressed in terms of the CO_2 content of the chimney gas.

This expression reduces to the following form:

$$R = \frac{0.209\left(1 + S\frac{3H}{C}\right)}{S\left(1 + \frac{3H}{C}\right)}$$

In this expression

R = Ratio of air admitted to air needed;
S = Per cent. CO_2 in the flue gas;
H = Per cent. hydrogen in the fuel (not oxygen bound);
C = Per cent. carbon in the fuel.

Fig. 4 represents graphically the results calculated from this expression, for fuels with different hydrogen-carbon ratios and may be helpful to some who are replacing coal with fuel oil, showing the marked difference in the excess air and the corresponding difference in the furnace economy shown by the two fuels, even while giving about the same CO_2 per cent. in the flue gases.

Regulating Fuel-Oil Burners

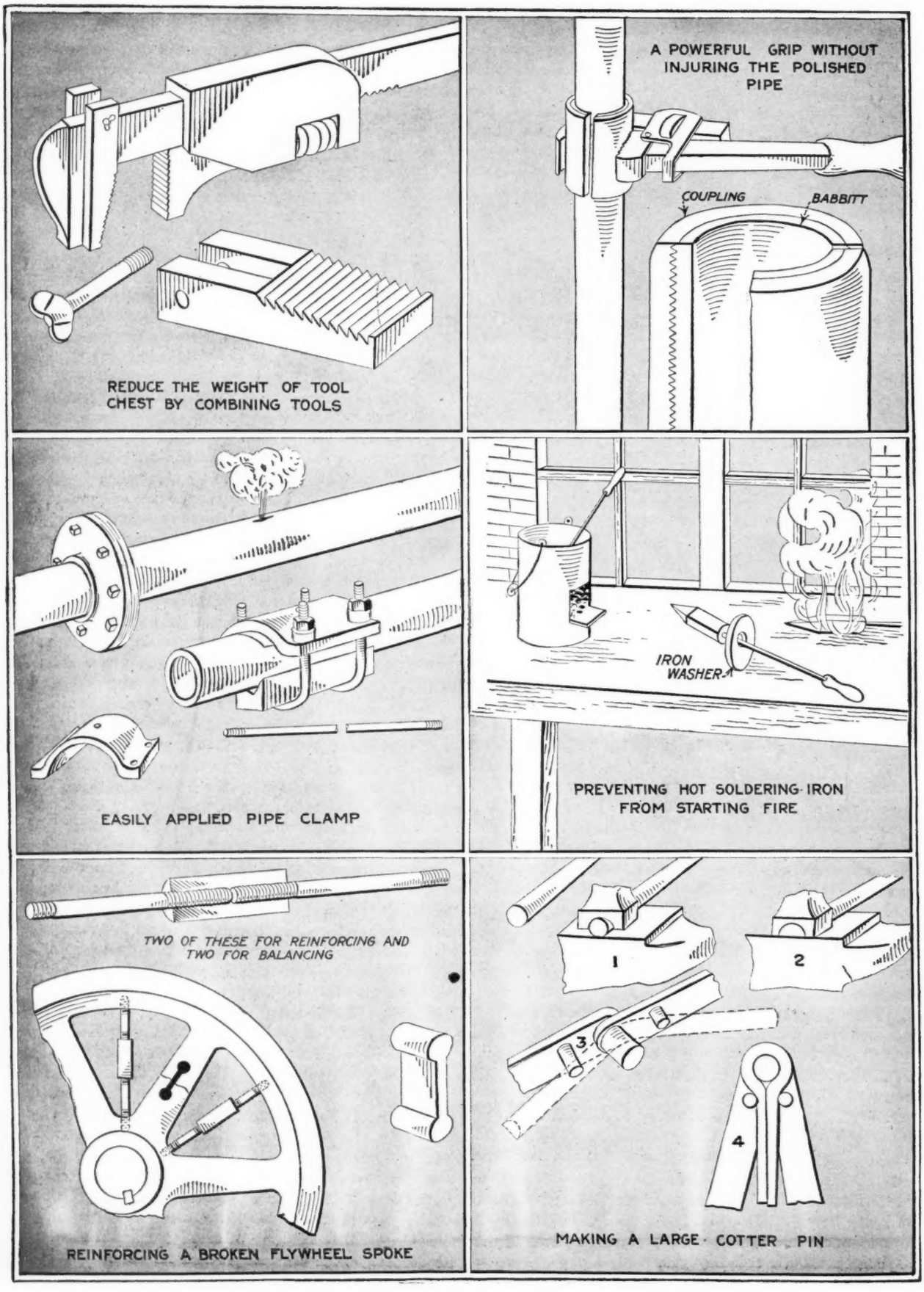
BY F. DRYNAN

There are two methods of governing the pump supplying oil burners—by the oil pressure and by the steam pressure. In the first method the oil pressure acts on a diaphragm and is opposed by a spring so that when the burner valves are opened and the oil pressure decreases, the decreased pressure on the diaphragm is overcome by the spring, opening the throttle valve wider, increasing the speed of the pump; but when the oil burners are again throttled, by hand, the pressure on the diaphragm is increased and the throttle valve is partly closed, reducing the speed of the pump. By this means the oil is maintained at a constant pressure which necessitates the regulation of the oil burners by hand for variations in steam pressure.

By the steam-pressure method of governing, the boiler pressure, instead of that of the oil, is made to act on the diaphragm so that any variation in steam pressure increases or decreases the speed of oil pump, thereby varying the oil pressure while the orifice admitting oil to the burner remains constant.

I once had charge of a plant where the latter method was in use, but soon found that the fireman took undue advantage of a good thing. The practice was to set the atomizing steam valves on the oil burners at a point where they would care for about the average quantity of oil going through the burner for the average load. The steam-pressure fluctuations were very small but at the expense of economy, for when the load was light more steam was used than was necessary and sometimes the chimney emitted large volumes of steam, but on the other hand, there were times, during heavy loads, when the oil did not receive enough steam to atomize well, causing smoke. Another bad feature was that the damper was opened to take care of the maximum load and left so. By changing so the pump was governed by the oil instead of the steam pressure, the firemen were compelled to pay more attention to the burners and fire, because the steam pressure changed with each variation in load. While the steam line on the chart was not quite as even as formerly, there was considerable saving in oil. The firemen were also "made acquainted" with the damper and its uses.

Some Handy Kinks



Editorials

No Fuel for the Enemy

THE Netherlands is incensed, the Scandinavian countries worried and South America apprehensive over America's embargo on the exportation of fuels and foodstuffs. All admit the President's legal right to declare such an embargo. Not unmindful of deep-seated German influence in these countries which directly or indirectly does much of the howling, we in America regretfully realize that Holland and the Scandinavian countries are short of food and fuel. But so are we. Assign what reason you will, the world is living from hand to mouth. It is not alone the above countries that come to America with outstretched hands pleading for fuels, foods and materials. Our Allies, those who are spending to the limit of their resources their money and blood, come too. After them come the neutrals.

Bryans, La Follettes and Bertrand Russels may vaporize about the ideal; but the conduct of cultured nations driven into a corner is governed by their vital, though not necessarily selfish, interests. When most of the world is neutral, the voice and arm of the neutral are stronger than those of belligerents; and conversely, with all great nations at war, the neutral acquiesces in the dictates of the belligerent or, to preserve his rights, himself becomes one, just as this country did after thirty-two patience-exhausting months.

It is not because we want to see neutrals hungry or cold that we keep food and fuel from them. We do so that we may not seriously lack these when prosecuting our most gigantic undertaking. Aye, more, that the very foundation of democracy may not be crushed by helping the enemy through neutrals domineered by the enemy.

We must tighten up on our beneficence to neutrals for the same reasons that we abandoned the volunteer system for the draft system; for the same reasons that we float bonds of billions and tax directly until the individual chafes under the burden; for the same reasons that we commandeer the merchant ships, license food dealers and tell our mine owners what they shall sell coal for—because we have got to do it to win the war and all that that means. Even now the fuel situation in the United States is serious. We must improve it; not make it worse.

For many weeks the New England coal market was suspended; there was no buying and no selling. The great textile centers have been running along with little or no supply on hand and with future shipments problematical. The mayors of Middle-Western cities have been commandeering coal passing through their towns, and President Wilson has had to relieve fuel-less Ohio by drastic action. Barges may be had at Hampton Roads, but it is indeed trying to get tugs or boats to tow them. The labor in coal mines is worse than restless, and anxiety about the future of the railroads daily grows more intense. Drastic Federal action has been necessary to insure fuel to the cold industrial Northwest. Public utilities have in many localities experienced temporary shutdowns. More facts might be presented; but these should be enough to show how we need coal.

Americans are not exponents of Kultur or rampant neo-Darwinism; but we are sensible enough to know that "'Tis sometimes necessary to be cruel to be good."

Needed Improvement in Stokers

NOT long ago Van H. Manning, Director of the Bureau of Mines, was reported in the daily press to have said that owing to wasteful methods in steam-power plants, millions of tons of coal were wasted annually in the United States. This is indeed a humiliating accusation. The deplorable part of it all is that so much of it is true. It becomes worse under the present conditions inasmuch as the unprecedented expenditures due to war have caused the world to cry out, "Conserve!"

While speaking of this waste it is well to remember that inefficient operating methods are not responsible for all the waste that takes place in the combustion of coal in boiler furnaces. With the advent of high boiler ratings there has come about a waste which in some plants does much to offset the gain that may be realized by operating the boilers at high capacities. This waste is occasioned by loss of combustible to the ashpits in some stoker-fired boilers.

It was surprising to hear the superintendent of a large and modern power station admit recently that from 28 to 50 per cent. of the ash from the boilers in his plant, depending upon the combustion rate, was combustible; the coal averages about 33 per cent. volatile. In this plant it is necessary during most of the day to operate the boilers at more than 300 per cent. of their normal rating. To do this the stokers are driven so hard that the fuel finds its way to the dump plate before the combustible in it is burned out. This case is not unlike those presented by most of our heavily loaded stations, which are large users of fuel, although the conditions in this plant are unusually extreme, particularly at the high combustion rates.

It is true that 50 per cent. combustible in the ash sounds higher than the amount is when compared to the fixed carbon in the coal; but for coals that are high in ash it is appreciable, and should not go on when much of the loss may be avoided by providing air admission and control to the ash before it is dumped to the pit.

While it would be unjust to say that all stoker manufacturers have left to the users the development of many needed improvements, it is a fact that some makers are not without blame in this respect. It surely is not the station engineer's business to develop a stoker

so that it is flexible enough in capacity range to economically burn fuel for which it was originally designed. Such is properly the function of the stoker manufacturer, who is always assured of the coöperation of the station engineers. It should not be a difficult job to make a stoker sufficiently flexible to operate between low ratings—that is, below the normal rating of the boiler—and extremely high ratings, or those which necessitate running up to 450 per cent. normal. The problem reduces itself chiefly to a matter of air distribution throughout the fuel bed and to the dump-plate where ash high in carbon collects at high combustion rates, and secondly, to the avoidance of clinkers of serious size and composition. There is nothing new about a stoker so designed, and on the other hand, there is nothing, so far as we know, that makes it impossible for other manufacturers to apply the same improvements to their stokers.

This is the most needed improvement in the mechanical stoker today, and as engineers depend so much upon the stoker to make possible savings in investments in installed boiler capacity, and secondly, because of the extremely high price of coal, which will, undoubtedly, never again be so low as it was before the war, engineers may rightfully demand that the manufacturers improve their stokers in this direction where needed. It would seem that manufacturers whose apparatus lacks in this respect should be only too anxious to provide such improvements in order that they may enjoy more equal advantages in competition, which for them must become more and more acute on account of the impetus that high-cost coal and an extremely restless boiler-room labor market will give to the stoker industry.

Power Development in Siberia

ON ANOTHER page in this issue attention is directed to the future possibilities of power development in Russian Asia. Today Siberia is interesting to the power engineer not on account of what has been done, but because of what may be done in the future. The skill of the power engineer may be tried severely until the solution is found which will give to Siberia a power supply that is both cheap and permanent. Siberia apparently expects to receive help from America. The American engineer, who has solved so many engineering problems both at home and abroad, will find a fertile field for his inventive ability and resourcefulness in Siberia. As it is, we all are too much inclined to rely on precedent whenever we approach a difficulty. A country like Siberia, however, will not permit the rule of technical experience alone. It is a country with conditions vastly different from those found in the United States or indeed in any other country of the world. The rivers are frozen for six and seven months a year, water is not always suitable for steam generation, and the transport of all kinds of fuels is expensive, consequently the economical generation of power offers a serious problem. On the other hand, it is generally realized that the country needs the supply of power if ever it is to attain that development which will be necessary to make possible colonization on a larger scale. Unusual conditions, however, often produce exceptional remedies. The engineer will have to make the problem of his customer his own and must find some method of solving it. If he does this, he will find that he has not only benefited his customer, but also helped to advance himself and those whom he represents.

In Siberia the problem becomes still more intensified by the fact that the prospective user of power so far has not quite realized the great possibilities of industrial and general development offered by the assistance of cheap power. If the help of the American power engineer shall become effective, it is essential that he should approach his prospective customer with the scheme ready in hand. He should offer a complete power installation for a mine or for an industrial lighting and power plant. This offer should contain everything that is likely to be needed in making the installation, and it should also explain why the installation will be of use to the buyer. Siberia is not exactly a wealthy country, but it certainly cannot be called a poor one. There are a great many rich mine and other property owners who may become buyers of power machinery and finally must do so.

It is essential that the American engineer going to Siberia for the sake of study should stay for a considerable period and make the country his home. If he can introduce sufficient small business to make it worth while for his firm to keep him in his position, he will find that occasionally a big opportunity will turn up. It will most certainly be taken care of by that firm which has its representative on the spot. This is the way other countries have succeeded in Russia, and there is no doubt that at present it is the only way. No firm will get the big business unless it has taken care also of the smaller wants of the country.

Careless wiring of power-plant conveniences may do little harm to the station where only low-voltage circuits are involved, but it damages the engineer's reputation in the eyes of the critical visitor and should not be tolerated. Ingenious labor-saving equipment of home-made design is the pride of many an installation, and in the enthusiasm of making such apparatus work satisfactorily, the importance of putting in a mechanically and electrically perfect job is now and then overlooked. If such wiring presents a ragged or slovenly appearance, the impression logically follows that the man who did the work is heedless of the fine points of his problems. Moreover, loose or slack wire, even of small size, may cause trouble in the way of mechanical obstruction in locations apparently out of easy reach, and sooner or later the practice of placing such circuits in small-diameter conduit should be taken into serious consideration.

This war is the greatest catastrophe the world has ever known. Any concern that can come out of it with its business unimpaired is in luck; any that can continue to make a fair profit through the time of stress is indeed fortunate; any that seeks to take advantage of conditions to profiteer, that impairs over-all efficiency in the interest of individual gain, that impedes progress and increases hardships by lobbying, hoarding, withholding, conspiring, combining and overcharging is traitorously criminal, and this applies to those who sell labor as well as to those who sell coal, steel and food products.

Correspondence

Leveling Two-Drum B. & W. Boilers

There is usually a certain amount of settling of the foundations of boilers that have been in use for several years, and as all piers do not go down the same distance, the boiler has a tendency to get out of level, aggravated perhaps by the unequal expansion of the circulating tubes and the nipples connecting the drums with the headers, causing the drums to roll, throwing the steam flanges out of level and putting excessive strain on the cross-pipe, which in some cases has been sufficient to cause rupture.

In one case the 15-in. steam flanges were found to be out $\frac{3}{16}$ in. sideways and $\frac{3}{64}$ in. endways. The side roll was probably caused by the unequal expansion of the nipples and the settling of the foundation. The following method was used to put the drums level and the tubes back in place:

After taking out the arch, the stoker was pulled out clear of the boiler and enough of the sidewalls removed to secure a firm foundation at each end in line with the front header and the mud drum in the rear, then a 12 x 12 timber was placed across under the front header, resting at each end on jacks, which were raised until the weight of the boiler was taken off the U-bolts and a similar support was put under the mud drum; then all the front nipples were cut off with a ripper, letting the front end of the drums down on the U-bolts again and leaving the tubes and headers supported on the timber and jacks.

It was found necessary to clamp the tubes just back of the headers with long rods and plates to keep them from spreading. The same was done at the rear, all the long circulating tubes being cut, leaving the drums resting in the U-bolts and connected to the headers. The drums were now ready to be leveled, the cross-pipe connecting the steam flanges having been previously taken off. The drums were now rolled enough to make the flanges level sideways, and the U-bolts were pulled up or let down as needed to make them level endways and with each other.

The cross-pipe was found to be distorted from the strain it had been under, and the flanges had to be planed to fit the flanges of the boiler, after which it was bolted on to prevent the drums from turning while the rest of the work was being done.

The headers were now jacked up to make the top row of tubes level and to get the right distance from their tops to the drums; then the outside nipple of each drum was rolled in front and rear, and the jacks were lowered so as to put a slight strain on the eight nipples and so hold the drums steady while the rest were being put in. Before putting in the rest of the nipples, the cross-pipe was loosened to make sure that no strain had been put on it, then it was bolted into place again and the rest of the nipples rolled in. All nipples front and rear were rolled first with a straight, then with a bell roller.

This completed the work with the exception of putting in the arch and rebuilding the side walls where they had been removed.

There was no trouble with the short nipples from the rear headers to the mud drum, and they did not even need rerolling.

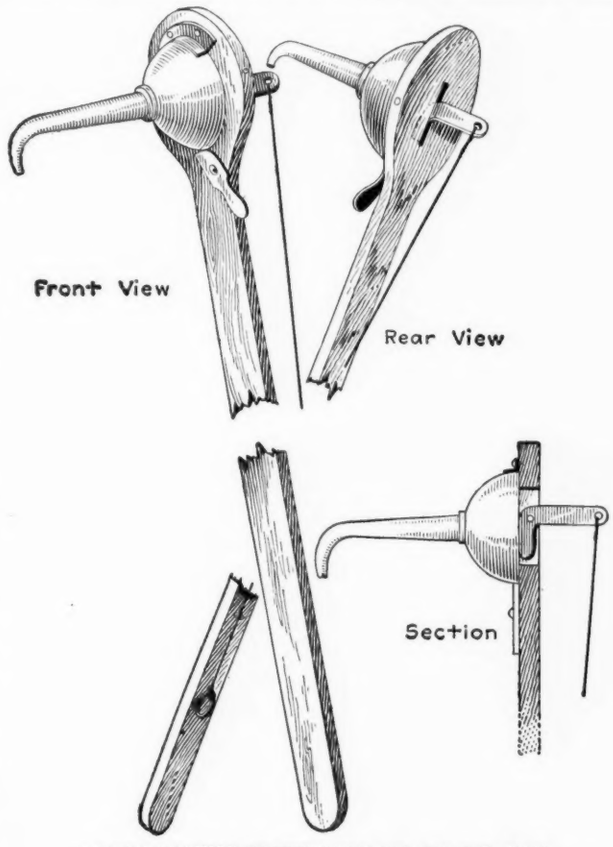
In a job of this kind great care should be used to see that the tubes and headers hang clear, their full weight being hung from the drums and all the weight on the U-bolts, and that there is no unequal strain on the nipples front or rear.

R. E. CLIZBE.

Clinton, Iowa.

Extension for an Oil Can

The illustration shows a simple device that will save much of the energy usually expended in climbing a ladder to oil countershafts, lineshafts, etc. The little lever at the back of the oil can, with the wire attached and with the ring placed at a convenient position on the handle, is for the purpose of pressing the bottom of the oil can. Of course this rig cannot be used to oil loose pulleys and the like, but will be found useful in a great many places.



LABOR-SAVING EXTENSION ON AN OIL CAN

WILLIAM FORRAY.

Brooklyn, N. Y.

Flexible Power-Plant Organization

Modern power stations are decidedly complicated, and the tremendous advance in size and type of power units in use has made the up-to-date engineer hustle; and to keep abreast with the swift tide of development, the engineer must be something more than a throttle man. With instruments to record almost every move of his equipment, with keen competition in the cost of production of current, he must be continually alert, lest the general efficiency of his plant get so low as to cost him his position and leave him stranded on the "Rocks of Procrastination."

Organization of Operating Force

One of the essential requirements of an up-to-date central station is the general organization of the operating force. Not only should the superintendent of motive power be prepared to advance most of his men all along the line, if his assistant should leave, but these men should be thoroughly "broke in" on all the various operations in the station. The men in the shift crews should be flexible—not only capable operators on their own shift, but competent to operate any of the other fellows' turns about the station.

A central station, well-known to the writer, that contains high- and low-pressure turbines, reciprocating steam engines, and blast-furnace gas engines, all in one building, furnishes a good example of a flexible organization. The station operates in synchronism with another owned by the same company, to equalize load conditions. The equipment consists of sixteen units ranging in size from 3000 to 12,500 kw. The plant operators are well-picked, high-grade engineers of proven quality, but that alone does not satisfy the superintendent of motive power at the head of the plant. All the steam engineers on each watch are capable of taking charge of the gas engines or operating the turbines, when needed, and all the gas-engine operators are licensed steam engineers capable of handling either the turbines or the steam engines temporarily.

Monthly Meetings Are Held

In the repair crew there are two licensed engineers capable of standing a watch in any of the three divisions in the plant. Nothing seems to interrupt operation, and the men are "on their toes" in the race for low cost per thousand kilowatts. Although not berated if the current cost for a certain month increases on their equipment, the entire operating crew is called into the office, and the total cost per kilowatt-hour for that month is told to them, but not to be made public. The operating conditions are thoroughly gone over and suggestions debated. The superintendent covers every detail of the controversy, with here and there a new operating suggestion to try out. No one is "bawled out," no one's job is in danger. If any one of the crew is getting into a rut or falling back in his general "snap" and efficiency, it is not unusual for the superintendent to talk it over with him at one of the monthly meetings, with the entire crew listening; he is not ridiculed, but merely cautioned and at the same time assisted in every way. No one goes out with a grouch after one of these "efficiency" meetings, but with a firm determination to better conditions and to help lower the cost for the next month. This superintendent keeps his men informed and has spent four years getting and organizing the grade of talent that would fulfill his requirement—thorough flexibility.

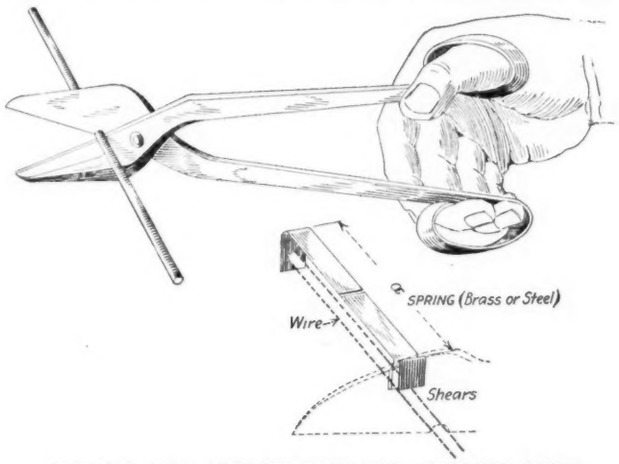
These extraordinary methods suggest the following: Let the men under you know what they are working for. Give them your aims concerning the plant, and don't be afraid of your men. Try this and you will probably note a decided change in the plant, its efficiency and dividends. Keep the crews flexible and see that they are able to operate the plant from any angle. A one-range field gun would be of little use in modern warfare. So it is with the one-point operating engineer; he is of little use in a real organization.

South Chicago, Ill. Albert L. Fritz.

Shears Used for Wire Cutters

Making one tool do the work of two is almost as important as creating conditions where one man may do the work of two, but the former is often overlooked

In the figure is shown a pair of shears with a nick ground in both blades near their fulcrum for cutting wire. It has proved to be very handy, especially when



SHEARS AND ATTACHMENT FOR CUTTING WIRE

the pliers are not near at hand or when the wire is too tough for the latter. The attachment shown at the bottom of the figure is for gaging wire to be cut in lengths for tie wires. The gage is made of spring steel or brass, and when slipped over the upper edge of the shear, will gage the length of the wire cut. M. P. Bertrande.

Ozone Park, L. I.

Drink While You Are Cool

I have recently made a discovery (although I may be behind time) that I think may be good for men in power plants to know when they have "hot jobs" to do. One evening, just before riding home from the plant on a bicycle, I drank a large quantity of icewater. I was surprised to find myself fairly cool, considering the hot evening and somewhat strenuous exercise, and I did not perspire so much as on other evenings. I tried the same thing out several times and found it was worth while, as I did not care for a drink of water for a long while after I got home.

It occurred to me that it ought to work out the same way when I had a hot job at the plant such as on top of

a boiler, so I tried it and find that I can "stay longer" and be more comfortable. My theory is that if a reserve supply of water is laid in to compensate for the perspiration, the body is not robbed of its natural moisture and there will not be so great a thirst as to cause one to drink a lot of cool water when the body is in a highly heated condition and lead to cramps and other disorders. Anyway, I would like to pass my "water cure" along to others. ARNOLD JAMES.

St. Louis, Mo.

Replenishing Air in Pump Chamber

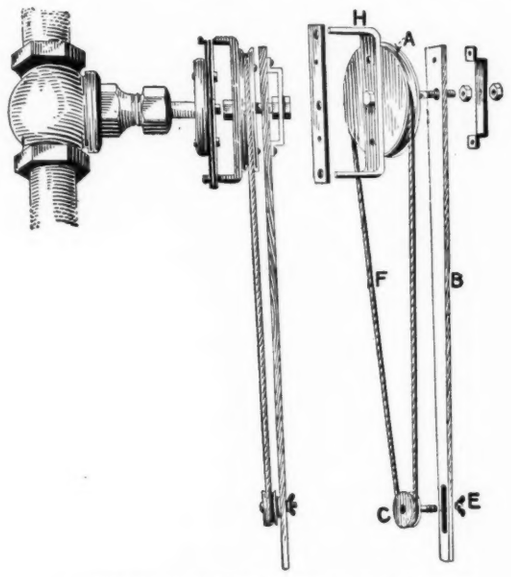
The easiest way to replenish the air in the air chamber of a pump is to tap the suction line about 12 in. from the pump and put in a ⅛-in. pet-cock, which will let in all the air needed for quite a large pump if left wide open.

By keeping the air chamber filled with air, the speed and capacity of the pump can be about doubled and the air will cushion the water and relieve the shock on the pump at the end of each stroke.

Warwick, R. I. GEORGE L. BRUNING.

Operating Overhead Valves

The illustration shows a portable device for opening and closing valves located overhead and out of reach, which can be made in a short time. Very often a ladder is not to be had when needed in a hurry, and it is sometimes in danger of coming in contact with shafting and belts in motion. There are no ropes or chains left hanging as are sometimes used for operating valves, and in many cases fixed handles of any kind cannot be used, as they would be in the way. This device will do the work, and it can be removed and placed somewhere convenient to get when required. It is easy to attach and does not cause a side pull or strain on the valve spindle. The construction is so simple as to require no explanation. On small valves it is best to attach a crossbar as shown for convenience. J. O. MCDONNELL.



PORTABLE VALVE-OPERATING DEVICE

Toronto, Ont., Canada.

Engineers' Examinations

The examination for an engineer's license, to be adequate, should be based on good practical modern power-plant operation, and it should have for its groundwork the economical use of fuel, treatment of feed water, care of boilers and their various appurtenances, such as stokers and boiler-feeding apparatus, and the use of instruments for determining plant efficiency, which should be thoroughly understood by every engineer. It is not essential for the candidate to know the whys and wherefores and all the details of these instruments, but he should know what they are for and how to use them. He should not have to wait for luck to bring him in contact with those devices just because his plant owners are too ignorant or hidebound to furnish them. They should be found in the classroom and also in the examination room. The question of lubrication should also be gone into and demonstrated in the class and examination rooms, and the examiner should be thoroughly familiar with these subjects in order to qualify for his job of passing judgment on the proficiency of others.

CRAMMING FOR EXAMINATIONS

The candidate, in order to pass the average examination, tries to memorize for examination day all about the alignment of an engine, horsepower, steam consumption per horsepower-hour, velocity of steam in pipes and various other things, even if he does not know the ABC of economical operation. In fact, it is waste of time for him to bother his head about valve proportions, eccentric throw, etc., for these things are determined for him in the factory and if he knows what is good for him he will not try to alter them. So he need not worry about whether there is a lap or anything else on his valve so long as he can get a good card; or if, setting by trial if he has no indicator, he cannot get good results he probably will not find anything wrong with the valve proportions, but more than likely will find something wrong with himself if he will think it over. He may be too busy trying to figure the bursting speed of the flywheel, the effect of angularity of the connecting-rod or something of that sort, to know that a bearing is sick when he sees it smoking. Would he in the latter case look into the matter of his lubrication, or would he proceed to show up the defects in the design and composition of the aforesaid bearings due to the ignorance of the man who built the machine? Most likely the latter because, foresooth, he is an engineer. There is his certificate of competency hanging on the wall to prove it. There was nothing in his examination about lubrication. He couldn't bother his busy head about oil anyway, that was for the oiler; his are questions of strength of riveted joints, Board of Trade, Lloyds and other inspection rules, etc. He is content if steam is up and held, without any thought of cost.

The day has gone by when engineering knowledge, even so far as the stationary engineer is concerned, can be carried in one's head. The field is too wide. As for myself, I know less about engineering now than I thought I did when I received my first papers; but at that time I could reel off formulas like a "blue streak," while now I have to look up a handbook, as a rule—it is more convenient and more apt to be right. The point I

desire most particularly to bring to the notice of engineers is that engineers' examinations should be confined more to practical operation than to abstruse theorems. In fact, the whole engineering profession is striving for one end—fuel economy and efficient operation, and that means a far different thing from what the average candidate is led to believe.

The matter of engine design can safely be left to the manufacturer, for he will supply just what is needed if given a chance and will give the benefit of a lifetime of experience in matters over which the engineer would only be wasting his time. One thing the manufacturer cannot do is to stay and operate the plant. Engineers should learn to operate efficiently and learn all they can about it.

In the examination room I believe there should be a model plant, and that the examination should be under experienced engineers, who are handling worth-while propositions and not "dead ones," and that insurance inspectors or Government boiler inspectors should be represented on the board. I should like to see this matter taken up all over the country so that we might some day see adopted a standard set of rules that would be uniform and binding throughout the American Continent. Great good would result, and the employer would know when he got a certified engineer that both his plant and pocketbook were safe, and the engineer would know when he got his highest grade of license that he had achieved something lasting.

Plant owners should take a hand in this matter and not leave it to the engineers themselves to improve conditions. They are the ones who will profit most, for when they want an engineer they want "the goods," not a meaningless label. J. A. McGILLIVIARY.

Trenton, N. S., Canada.

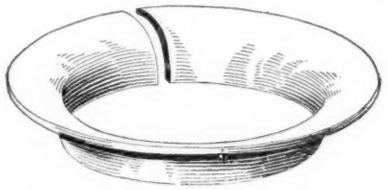
Imprisoned in a Boiler

The method employed in extricating a man from the inside of a boiler, described on page 403 in the issue of Sept. 18, appears to be an excellent example of pure boneheadedness. It is well known that the human body, like many other substances, expands under the influence of heat. This may be demonstrated by placing a snug-fitting ring on a finger, then holding the hand in warm water for a short time. It will be found almost impossible to remove the ring until the hand has again been cooled.

As the temperature on the inside of a boiler is generally greater than that on the outside, a man's body will soon expand, and in case he nearly filled the manhole when entering, it may be impossible for him to get out in a heated condition, but such an occurrence does not call for an enlargement of the manhole or even greasing the body. A few pails of ice water properly applied will reduce the subject to normal size so that he can get out through the manhole through which he got in. I have known of several cases where cold water has been successfully applied.

Del Monte, Calif. A. C. McHUGH.

The story under the heading, "Imprisoned in a Boiler," in the issue of Sept. 18, page 403, calls to mind a similar experience with which I was concerned, and how the imprisoned man was extricated from a 16-ft. return-tubular boiler with the same design of manhole ring as that of the Union League Club boiler. The workman had been able to get into the boiler easily, he told me at the time, and I concluded there was no other reason for his inability to get out than the "grabbing" of the sharp edge of the ring which extended downward and rounding to the upper or outer side,



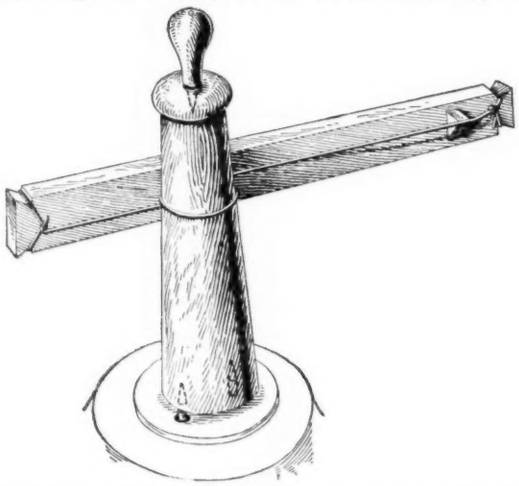
SHEET-IRON RING FORMED AND PUT IN MANHOLE

making a sort of funnel shape with smooth sides to enter. I hammered a strip of 18-gage sheet metal into the shape shown in the illustration and placed it in an inverted position in the boiler manhole ring so that conditions for getting out were the same as those for getting in. This, along with the effect on the mind of the imprisoned man, made it an easy matter for him to get out even without removing his clothing.

Harvard, Neb. JULIUS E. PERSON.

Grinding in a Gas-Engine Valve

Anyone going out from the shop to do repair work cannot carry many tools with him—at any rate not enough to do all kinds of jobs—and consequently often has to "rig up" for a job. I recently had to regrind the exhaust valve in a small horizontal gas engine, but not knowing what the job was when I started, I had



IMPROVISED FIDDLE BOW FOR GRINDING A VALVE IN

no valve grinder. The valve seat was cast integral with the cylinder and was about 3 in. from the outside of the engine, and there was no more than 6 in. of room back of the cylinder. There were two spanner holes in the valve so as a means of rotating the valve I sawed off about 6 in. of the handle end of an old baseball bat and drove two nails into the end to match the holes in the valve and used a brad-awl for a pivot bearing at the other end. Then with a piece of cord and a pine stick I improvised a fiddle-bow driving device, as shown in the illustration, and ground in the valve quickly and easily. A. J. CAHEN.

Brooklyn, N. Y.

Inquiries of General Interest

Ammeter Reading in Positive and Negative Sides of Circuit—Should an ammeter register the same in the negative as in the positive side of the circuit; and should the positive busbar be larger than the negative? N. H.

An ammeter will give the same reading in the negative as in the positive side of the circuit, and the positive busbar should be the same size as the negative.

Blistering of Water Tubes of Boiler—What causes the tubes of water-tube boilers to become blistered? J. W. M.

Blistering may be due to overheating from deposits of oil or scale on the inside of the tube, or from driving the boiler so hard that the generation of steam drives the water away from the tube surface, in either case preventing the rapid transfer of heat of the fire to the water of the boiler.

Horsepower Developed by Pumping Engine—What number of horsepower would be required for continuous operation of a pump against a head of 65 ft. for a stored water-supply of a city of 25,000 inhabitants, with a per capita consumption of 180 gal. per 24 hours? M. O. D.

Allowing 8.33 lb. per gal., the water horsepower of the pump would be

$$\frac{25{,}000 \times 180 \times 8.33 \times 65}{24 \times 60 \times 33{,}000} = 51.27\ hp.$$

Allowing a mechanical efficiency of 90 per cent. for the pumping engine, the power developed would be 51.27 ÷ 0.90 = 56.96 indicated horsepower.

Parallel Operation of Alternators—If two alternators are designed for the same voltage and frequency but run at different speeds, can they be operated in parallel; and if so, what procedure is followed in putting the machines in parallel? P. E. M.

Two alternators of the same voltage and frequency can be operated in parallel irrespective of their speed. For a given number of cycles, the speed is determined by the number of poles. If the alternators are alike except in the number of poles, they are put in parallel in the usual manner of putting two alternators in parallel; namely, by adjusting the machines to generate the same voltage and frequency, then synchronize them and close the switch.

Oil Trouble in Gas Engines—We have a 12-hp. three-cylinder vertical gas engine that has been in service for about ten years, but for the last year the oil supply to the crank case has required more frequent replenishing, the oil working up past the pistons. We have the same trouble with a two-cylinder vertical gas engine in which so much oil works up past the pistons as to ooze out around the igniters, causing them to fail in operation. Lowering the height of oil carried in the crank case or new piston rings do not remedy the trouble. How can it be prevented? C. E. N.

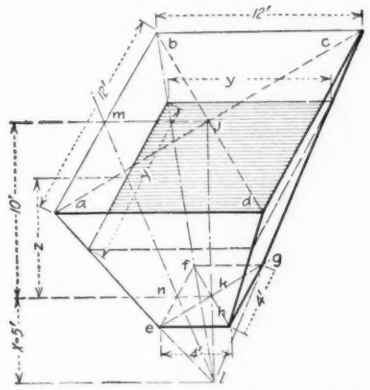
This fault in gas-engine operation is common from want of closeness in fit of the piston rings to the walls of the cylinders. New piston rings have not cured the trouble because the cylinders were worn out of round. The remedy would be to rebore the cylinders as well as to supply close-fitting piston rings.

Degrees Superheat of Steam—What is meant by the degrees of superheat of steam, and how is it determined? L. D.

The amount of superheat, or degrees of superheating, signifies the number of degrees by which the actual temperature of the steam exceeds the temperature of the boiling point, or temperature of dry-saturated steam, corresponding to the given pressure. If, for instance, the gage pressure is 110 lb. per sq.in. and a thermometer inserted in the steam shows that its temperature is 450 deg. F., by reference to steam tables it may be found that the temperature of dry-saturated steam at 110 lb. gage, or 125 lb. absolute, is 344.4 deg. F. and there would be 450 — 344.4 = 105.6 deg. of superheat.

Dimensions of One-Half Content of Pyramidal Tank—A tank is 4 ft. x 4 ft. at the bottom, 12 ft. x 12 ft. at the top and 10 ft. deep. What will be the depth of water when the tank is half full, and what will be the length of one side of the tank measured at the surface of the water? W. L.

The tank would have the form of the frustum of an inverted pyramid. The volumes of pyramids and their frustums depend upon their altitudes and the areas of their bases, and for purposes of computation the tank may be assumed to be a frustum of a right pyramid with square base. In the figure let *abcd* represent the 12 ft. x 12 ft. top of such a tank and *efgh* the 4 ft. x 4 ft. bottom. Connect the diagonals *ac* and *bd* intersecting at *j*, and *eg* and *fh* intersecting at *k*. The depth of the tank then will be represented by *jk* = 10 ft., and *jk* produced will pass through the apex *l* of the completed pyramid. Connect *j* with *m* at the middle of *ab*, and connect *k* with *n* at the middle of *ef*, and draw *mnl*. In the triangles *mjl* and *nkl*, *jl* : *jm* : : *kl* : *kn*. Let *kl* = *x*, then as *jk* = 10, *jl* = 10 + *x*, *jm* = 6 and *nk* = 2; and from similarity of the triangles 10 + *x* : 6 ft. : : *x* : 2 ft., from which 20 + 2*x* = 6*x* or *x* = 5 ft., and the altitude *jl* = 15. The volume of the completed pyramid will be ⅓ × 15 × 12 × 12 = 720 cu.ft. The volume of the pyramid *efghl* would be ⅓ × 5 × 4 × 4 = 26.66 cu.ft. Therefore the full capacity of the tank would be 720 — 26.66 = 693.34 cu.ft., and when half full the tank would contain 346.67 cu.ft. If the length of one side of the tank measured at the surface of the water is taken as equal to *y*, then the filled portion together with the pyramid *efghl* would form a pyramid whose volume would be 346.67 + 26.66 = 373.33 cubic feet.



As the pyramid with base *y* × *y* would be similar to the pyramid with base 12 ft. x 12 ft., then $y^3 : 12^3 : : 373.33 : 720$, or $720y^3 = 12 \times 12 \times 12 \times 373.33$; $y = 9.64$ ft. Calling the depth of the water *z*, the altitude of the pyramid having a base equal to the upper surface of the water would be *z* + 5, and as *z* + 5 : *y* : : 15 : 12, or *z* + 5 : 9.64 : : 15 : 12, then (*z* + 5) × 12 = 9.64 × 15, or *z* = 7.05.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Recent Progress in Internal-Combustion Engine Valve Gears

By R. E. MATHOT

Because of the difficulty experienced in eliminating detrimental reacting forces upon the governor controlling simultaneously several admission gears, considerable thought has been given to the design of such gears. The following, by R. E. Mathot, from "Gas and Oil Power," London, is of interest, in that it describes improvements that eliminate the troubles mentioned.

THE different types of admission gears nowadays applied for varying the stroke of the inlet valve without having recourse to the trip gear exert detrimental reacting forces upon the governor. As a consequence, a single governor cannot be used with good results for controlling simultaneously several admission gears, as is the case in double-acting engines or in engines with several single-acting cylinders.

Regarding the timing of the ignition device, it is usually operated by hand after an empirical method, while logically it should be operated automatically in accordance with the load of the engine and be so much less "advanced" accordingly as the engine is more loaded.

The regular make-and-break device applied to low-tension magnetos presents the defective peculiarity that the oscillation of the armature, and consequently the power of the spark, is lessened in proportion as it is retarded, while normally whatever the time of ignition may be, the spark should always be maximum.

A patent has lately been granted on a special device consisting of an admission gear which avoids any detrimental reaction on the governor, while it also secures the action of a device that insures to the armature of the magneto a constant amplitude of oscillation, while it varies automatically the timing of a spark of maximum strength.

In Figs. 1 and 2 is partly shown the general arrrangement of the well-known admission gear, consisting essentially in a curved link *A* pivoted at *B*, which receives a rocking motion from a cam *C* fitted on layshaft *D* of the engine. The motion is conveyed to the inlet valve *K* through a radius rod *E* fulcrumed at *F*, with a rocking lever *G* pivoted at *H*. The outer end of the radius rod *E* can freely move along the link *A*, whose surface of contact constitutes a curve having a radius *E* with *F* as center, as shown in Fig. 1.

When the link *A* is raised (Fig. 2), according to the position at which the radius rod *E* is caught, either in the neighborhood of the fulcrum *B* or at the end of the link *A*, the rate of the motion is minimum or maximum as well as the motion of the rocking lever *G*, which conveys to the valve *K* a stroke, or opening, varying from nil to maximum.

The invention consists of the system of operating the radius rod *E* through the governor and without submitting it to any detrimental reaction.

For this purpose the radius rod *E* is provided at a suitable point with an arm *M*, pivoted at *L*, which, when the link *A* is not raised, rests upon the free end of a small bell crank *N*; this bell crank *N* is connected to the governor by rods or by any other suitable device, as shown in Figs. 1 and 2.

A spring, fixed, for instance, at *P*, provides an elastic connection between the radius rod *E* and the arm *M*. Moreover, the angle formed between these two pieces may be altered by means of a setscrew *I*, which bears upon a projection of the radius rod.

When the device is not in motion, the arm *M* is resting upon the bell crank *N*, through its own weight or through the action of a suitable spring, in such a way that the radius rod *E* will take, along the link *A* when at rest, the position given to the arm *M* by the bell crank *N*, which is operated by the governor *O*, Fig. 2.

Fig. 1 shows the system with the link *A* at rest, which is its position during the cycles of the engine corresponding to compression, expansion and exhaust. The full lines show the position of the radius rod *E* on the outer end of the

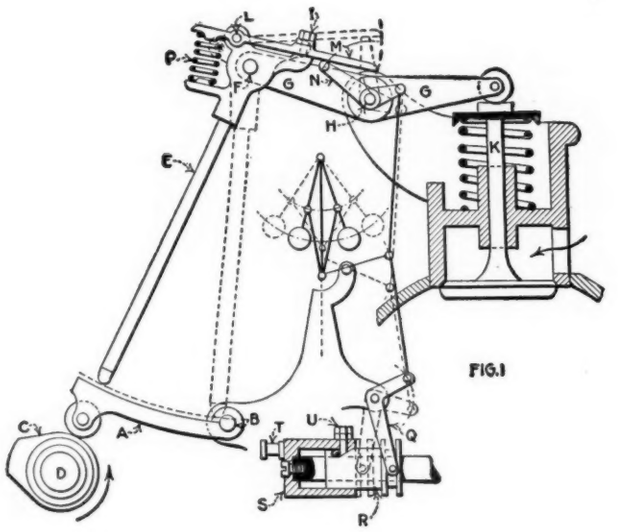


FIG. 1

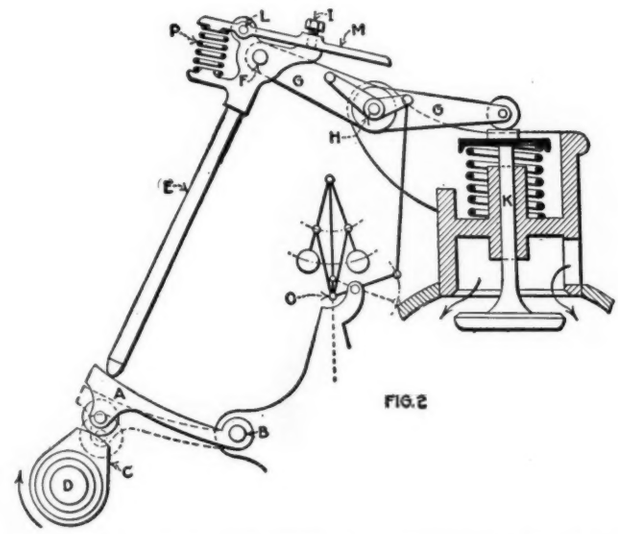


FIG. 2

FIGS. 1 AND 2. MECHANISM FOR AVOIDING REACTING FORCES ON GOVERNORS

Fig. 1—Showing "at rest" position (full lines). Fig. 2—The device in action

link *A*, providing for maximum admission when the governor is "closed." The dotted lines show the position for minimum admission with the radius rod toward the fulcrum *B* when the governor is "open."

It will readily be seen that every intermediate position of the governor will secure a corresponding position to the radius rod which moves freely along the link *A*, with the result of securing to the valve a stroke or opening which will vary from nil to maximum.

The opening of the valve, which takes place during the admission cycle, is shown on Fig. 2, with the link raised by

the cam and the radius rod in the position of maximum stroke.

Attention is called to the fact that during the three periods of the cycle, compression, expansion and exhaust (Fig. 1), the governor may freely move the radius rod along the link, thanks to a slight play existing between the surface of the latter and the bottom of the radius rod. Moreover, during the admission cycle, as soon as the link is raised and catches the radius rod, the arm *M* clears completely

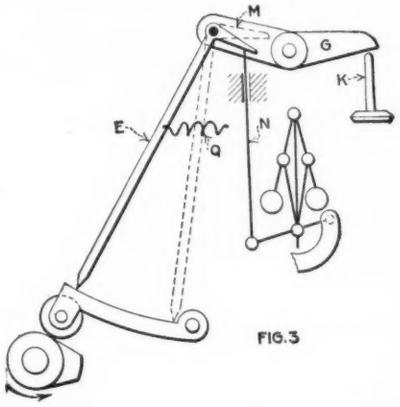


FIG. 3

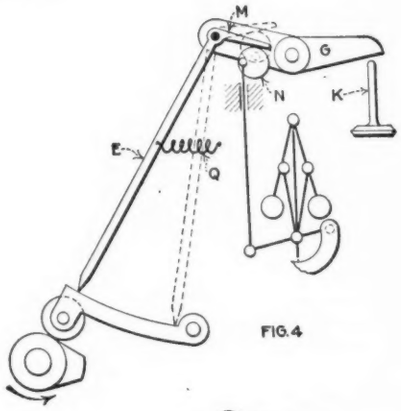


FIG. 4

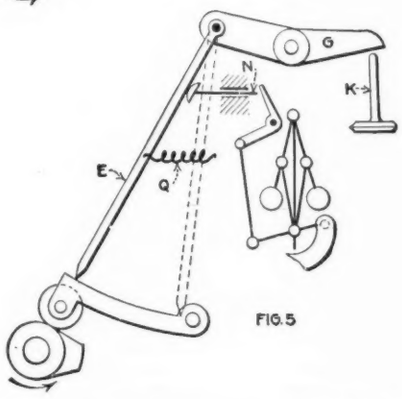


FIG. 5

FIGS. 3 TO 5. MODIFICATIONS OF DEVICE SHOWN IN FIGS. 1 AND 2

Fig. 3—Push rod giving movement to radius rod E. Fig. 4—Rod E moved by an eccentric. Fig. 5—Push rod acting directly on Rod E

the crank lever *N*, as a consequence allowing the governor to give any new position to bell crank *N* according to the load of the engine.

When, at the end of the admission cycle, the link is relieved from the cam *C* and takes its idle position, the radius rod will drop by the action of the spring of the valve *K* and will take the position secured to it by the arm *M* on the bell crank *N*, ready for starting the next admission stroke to the valve.

The principle covered by this new patent can be applied in somewhat different ways, as, for instance, in diagrams Figs. 3, 4 and 5, where a light coil spring *Q* tends to keep the radius rod in contact with the governor's operating device. The latter consists, in Fig. 3, of a push rod *N* acting on the arm *M* of the radius rod *E*.

In Fig. 4, instead of the bell crank *N* of Figs. 1 and 2, a small eccentric *N*, operated by the governor, acts upon the arm *M* to displace the radius rod.

In Fig. 5 a horizontal push rod *N* acts right on the radius rod itself.

These three forms of the device present the characteristic features that there is no rigid connection between the governor and the operating mechanism and that, according to the main claims of the patent, the radius rod is fitted in such a manner that it leaves and clears the governor gear as soon as it becomes operatively connected with the link for opening the valve.

This remarkable feature of the new gear makes it comparable, with respect to sensitiveness and independency, to the standard "trip gears," without, however, involving the complications and drawbacks inherent to the latter. By the very fact that the operation of the gear does not require any power from the parts of the governor, the latter may be of the light and powerless type, and a slow-speed axial governor, mounted on the camshaft, will secure a perfect regulation and a simple and neat-looking mechanism, when compared to the huge, bulky "speed-up" governors now in use for variable admission gears.

As no rigid connection exists between the gear and the governor, the latter will freely operate any number of admission gears simultaneously, as is the case with double-acting engines or with multi-cylinder single-acting engines.

Moreover, being relieved from any detrimental reaction from the part of the admission gear, the governor can be reliably applied to the timing of the ignition, as shown in Fig. 1, where the magneto-operating contrivance is diagrammatically shown in a "false view" at the end of the layshaft *D*. The operation is secured through adequate rods and levers *Q*, acting on a collar in the groove of a sleeve *R*. This sleeve is allowed to slide longitudinally on the layshaft by means of a key fitted on the shaft. The sleeve *R* moves inside a barrel *S*, shown in section, which carries the crank pin *T*, or the eccentric that operates the magneto.

This barrel is mounted on the layshaft by means of a strong screw that prevents longitudinal motion, but allows the barrel to turn around the shaft. To this end the barrel is provided with one or more pins *U*, protruding inside and engaging in corresponding helical slots cut in the sleeve.

The longitudinal motion of the sleeve *R* through the governor, while the layshaft is turning, causes the barrel *S* to move angularly backward or forward on the layshaft and by this means operates with more or less "advance" the make-and-break device of the magneto, while giving the latter a maximum constant amplitude.

Dr. Manning on the Saving of Coal

Talking to a representative gathering of men who are to assist the Fuel Administration in the different states, at their meeting in Washington with Dr. H. A. Garfield, Van H. Manning, director of the Bureau of Mines, Department of the Interior, said concerning the necessity of urging the economical use of fuels:

The economical use of fuel has proved to be no simple problem. The coal, the equipment and the human variables make hard-and-fast general rules impossible. The Bureau of Mines has carried on extensive experiments to determine the fundamental principles of the combustion process and of furnace design and at the same time has been making practical application of improved practice in Government power plants. Many publications are available which show the progress of the work along these lines.

Americans have been as wasteful of coal as of other resources, largely because coal has been abundant. To many consumers it has seemed hardly worth while to give time and thought to the saving of coal.

Conditions have suddenly changed. Today it is everybody's business to save coal. Coal is the foundation stone of industry. Without it the production of equipment for war must halt, transportation facilities must stand still. One man's careless and wasteful use may mean an idle

factory or a cold house for his neighbor. With the world looking to us largely for its coal supply, with increased demands at home, with a scarcity of available labor, with overtaxed transportation facilities, the consumer of coal must pause and give serious consideration to the problem which confronts the country.

If the consumers can be aroused to an intelligent consideration of the burning of coal, they can begin to save 10 per cent. of the production (600,000,000 tons) at once. With more effort, through instruction and a moderate remodeling of coal-burning equipment, which could all be accomplished during the war, a further considerable saving can be made. The possible coal saving when present practice is compared with the best ideal practice is very large. If it were possible to supply the need of this country for light, heat and power through the highest type of mechanical devices, and if we could make a skilled coal user out of the average user, we could probably get along with half as much coal as we are now consuming. This ideal is far beyond present realization.

The immediate problem is a difficult one. We cannot scrap all out-of-date power plants. We must start by doing the best with what we have. We must begin saving coal at once. The problem is personal. It deals with the human element. We must reach the man with the shovel.

About 15,000,000 people shovel the 20 per cent. of our coal used for domestic purposes. Only about 250,000 firemen shovel the 60-odd per cent. of our coal used by power plants and railroads. While we must appeal to the householder to save coal, it is vastly more important to reach the fireman through whose hands the larger part of our coal passes.

The householder must realize that when he throws a shovelful of anthracite into his furnace, its value is equivalent to half a pound of sugar, or half a loaf of bread, or a pint of milk. He must appreciate that it is worth while to examine his house and to overhaul his heating equipment. Weather strips, double windows, pipe coverings, clean flues and chimneys, and tight fittings in ashpit, doors, dampers and furnace parts will all pay. Damper control is one of the chief secrets of economical heating. Clean surfaces are most essential, as soot is a poorer conductor of heat than asbestos. Care, attention and taking pains will be the greatest factors in saving domestic coal.

The fireman is, however, the biggest single factor to be considered in a campaign to secure the largest saving of coal. Many manufacturers have made a serious mistake in failing to consider the fireman as a skilled worker. Too often he is treated as a roustabout. He is not well instructed nor given proper labor-saving devices. As coal increases in price or becomes difficult to get, the fireman handles more and more of his employer's money. His efficiency means more in dollars and cents. This is an encouraging feature in the situation. It means a better recognition of the importance of the fireman, more efficient work on his part and a consequent increased saving of coal. The viewpoint is changing. It is no longer cheaper to pay for the coal than to educate the firemen.

Proportioning Chimney on Fuel Basis*

BY HENRY MISOSTOW

Up to the present time proportioning of chimneys has been equivalent to solving several formulas given in handbooks and textbooks for this purpose. The majority of these formulas have been adopted from kindred fields of science and have been modified by changing a constant or adding one; oftentimes creators or advocates of this or that formula were ignorant of the actual practice. There is a legitimate reason for protest against the use of these formulas for the proportioning of chimneys without proper knowledge of the underlying principles to insure sound judgment. There is no better way to acquire sound judgment about a chimney than to study it, as it contains more information about itself than any other source.

The object of building a chimney is twofold: First, it should deliver sufficient fresh air to the fire to maintain combustion; second, it must discharge the products of combustion into the atmosphere. The chimney that will accomplish this work the cheapest is the chimney to be preferred, provided the quality of work is not impaired. From the foregoing it can be seen that the best chimney is the smallest one that will do the work as well as any other that can be made, workmanship and material being considered the same in all cases. Selection of the best chimney from a large number of possible ones is no easy task, and to do this work well the engineer must be able to foretell the performance of the chimney.

Contrary to the general idea the composition of chimney gases runs very uniform for the same class of service and differs little with different services. The services may be divided into two classes, low- and high-pressure. The former may be for heating and the latter for heating and power or power alone. Composition of the chimney gases is largely affected by infiltration of air through the setting and into the gas passages. The best-cared-for and largest plants are not immune from infiltration and often suffer more than the smaller ones. The sum of CO_2 and O_2 in chimney gases runs about 18 per cent. instead of 20 per cent. as in free air, and further investigation shows that the rest of the O_2 is absorbed by sulphur and hydrogen. Average results from a large number of chimneys investigated are tabulated in the following:

	Average CO_2, Per Cent.	Average Stack Temp., Deg. F.	Av. Vel. per Sec., Ft.
Low-pressure heating	4½	180	10
High-pressure	6½	450	25

This table is the average of many investigations and can be used as such, but the work of investigation should not be considered final or entirely completed. As the average intelligence increases, the operation, care and design will improve, and this naturally will tend to increase the CO_2 and decrease the temperature of the gases.

With the percentages of CO_2 given, the weight of the chimney gas can be figured closely. In the case of one or two boilers with the chimney directly connected, the CO_2 content in either type of plant may be considered 1 per cent. higher. The carbon accounted for in the gas is naturally moisture and ash free. As the heat value of all bituminous coals, ash and moisture free, is above 14,000 B.t.u., this may be taken as the heat value per pound of combustible. The weight in pounds per cubic foot of any gas at 32 deg. F. is equal to one-half of the molecular weight times 0.00559. Knowing the composition and temperature, the weight and volume of a gas can easily be obtained.

The quantity of the gas and the velocity are the two main factors determining the area of the chimney. Increase of the velocity increases the stack loss, but this loss is not as large as commonly thought. A velocity of from 10 to 40 ft. per sec. is met in practice. In low-pressure work an average velocity of 10 ft. per sec. and for high-pressure plants 25 ft. per sec. are good working averages. When sharp, short peak loads must be taken care of, a velocity of 30 ft. per sec. may be used. The rate of combustion is increased and this is followed by an increase in temperature, compensating for the increased draft loss due to a higher velocity. Friction head in the chimney usually remains inside of 0.001 in. of water per lineal foot height of the chimney when the velocity remains under 30 feet.

The difference in temperature and composition of the gases in the chimney and the outside air is followed by a difference in weight of the two columns. The total difference is the actual difference in weight of the two columns per foot of height, times the chimney height in feet, expressed in inches of water per square inch. Draft loss in the chimney due to friction is naturally not available. The available draft is equal to the difference in weight of the outside air and the gases in the chimney, less the friction loss in the chimney. Knowing the composition of the chimney gases, the weight may be determined. Generally, the weight of the air should be taken at the average temperature and weight at the place where the chimney is to be erected.

Draft required at the chimney will depend on the magnitude of the boiler plant as well as the type of boilers and the distance from the chimney to the boilers. This part of the work requires practical experience and familiarity with the type and size of boilers for which the chimney is to be designed, and no fixed rule can or should be given.

*Abstract of paper read at Twelfth Annual Convention of the Smoke Prevention Association, Columbus, Ohio, Sept. 25-27.

Chimney efficiency is often confused and the chimney is charged with all heat not utilized by the boiler. It is self-evident that the chimney should be charged only with the amount of heat above that required by the boiler. To maintain a reasonable rate of transmission a difference of 100 deg. F. must be maintained between the steam temperature and the chimney gases. The heat in the gases above this temperature—that is, steam temperature plus 100 deg.—can be charged to the chimney as used for draft production.

Mechanical draft is closely associated with more intense generation and transmission of heat than is required in the majority of plants at present. When the metal in a boiler is so distributed as to deliver a boiler horsepower on 3 sq.ft. of heating surface and the gases are discharged into the atmosphere near the temperature of the feed water, mechanical draft will be universal. As long as 10 sq.ft. of boiler-heating surface is allowed per boiler horsepower and the gases are discharged above the steam temperature, the efficiency and reliability of the brick chimney will be preferred.

Chimney height is determined by the amount of draft required. In cases where chimneys must be built higher than this, the area per pound of chimney gas can be reduced in inverse ratio to the square root of the height. The area is determined by the quantity of the gas per second and the velocity. As previously stated, a stack velocity of 25 ft. per sec. is a good working velocity, although for sharp, short peak loads a velocity of 30 ft. per sec. may be used. Chimney friction loss per foot under 30 ft. velocity per second will be inside of 0.001 in. of water. The gas weight may be obtained from the quantity of fuel required. The volume of gas is proportional to the temperature, and this may be taken as 450 deg. F. In all calculations absolute temperatures must be used. Draft required, divided by the available draft per foot of height, will give the stack height.

Available draft per foot of chimney for an average stack temperature of 450 deg. F. is equal to the actual difference in weight of the gases inside and outside of the chimney, expressed in inches of water per square inch, less 0.001 in. friction loss.

Composition of chimney gases can be taken as 6.5 per cent. of CO_2, 11.5 per cent. of O_2 and the rest nitrogen. From these figures the weight and volume can be obtained. Actual composition of the chimney gases varies slightly, there being a trace of CO, SO, SO_2 and slightly more nitrogen than was in the air. This is why the CO_2 and O_2 total 18 per cent. in chimney gases instead of over 20 per cent. as in free air.

The quantity of combustible required to provide the desired amount of heat can be taken as composed of pure carbon with a heat value of 14,000 B.t.u. The combined efficiency of the boiler and furnace can be considered as 60 per cent. for high- and 40 for low-pressure plants.

The foregoing data reduced for quick reference in practical work will be as follows: (1) Draft available per foot of chimney above the grate is 0.0053 in. of water; (2) combustible per horsepower, 4 lb.; (3) area required per pound of combustible will be 1.1 sq.in. for high-pressure plants; (4) area correction for chimney above 150 ft. high per pound of combustible is $(1.1 \times 12.24) \div$ square root of chimney height.

No claim is made that these data should terminate the study of the subject. On the contrary, further study is urged, and as operation and maintenance of the plants improve, the data should be modified to correspond to practice.

New England Coal Situation Critical

Resolutions declaring that the New England bituminous coal supply is in serious peril were transmitted to Washington Oct. 18 from a conference of governors and business leaders assembled at Boston to remedy the existing and threatened fuel shortage. The conference emphasized its earnest support of the Federal fuel administration and urged that everything possible be done to provide immediate and urgent relief in the situation now prevailing. Governor McCall, of Massachusetts, presided, and Fuel Administrator James J. Storrow, of New England, was the principal speaker. The latter pointed out that factories are running day and night in an effort to supply the Government with war material and that great danger of shutdowns exists on account of fuel scarcity. The total supply of coal for the first eight months of 1917 for New England was 17,414,000 tons, of which 7,993,000 tons was all-rail coal. This supply is far below normal, and if conditions do not improve, there will be a shortage of 6,603,000 tons by Jan. 1. Normally, two-thirds of the coal is water-borne, but the war has caused the withdrawal of many ships for other service, throwing upon the already overburdened railroads extra tonnage which they cannot adequately handle.

Mr. Storrow said that when the New England coal committee, of which he is chairman, took up its duties last May, it was found that shipments were about 300,000 tons behind those for the corresponding period of 1916. Through the coöperation of the producers and of Federal and railroad officials, direct train deliveries were arranged and the shortage was made up and a surplus of 550,000 tons obtained compared with the same period the year before. On account of night and day factory work, and also because of intensive production due to the war, more than the usual quantity of coal has gone into the making of steam. Distribution has been uneven also. The Boston shortage is less serious than that of New England in general. Bituminous coal is the important question. When the Government put a $2 price on it, existing contracts remained in force, ranging from $3 to $4 per ton, and all over the country contracts were made at higher than the Government prices. The mine owners could see no reason for selling at $2 per ton when the law authorized them to sell it at contract prices. Those who had contracts will get their coal first because they are preferred customers. The long haul to New England from the mines is a serious drawback.

In coöperation with the Federal Shipping Board, a dispatch system has been arranged for tugs and barges, with headquarters in Boston. Tugs are being utilized more efficiently by bunching barges, regardless of their owners. The worst difficulty, Mr. Storrow said, is that the coal does not get down to tidewater. If coal cars and motive power could be added, the production could be increased by millions of tons. On Mondays there are enough cars because of the Sunday layoff. This takes care of Tuesdays; but on Wednesdays the business begins to slacken, and there is a short day on Thursdays. On Saturdays the miners do not work at all. Much good has been accomplished by inducing consignees to unload coal cars more rapidly than in the past. While the railroads have tried to urge consignees to aid them in keeping the cars free, it has been found that the public or the quasi-public committees can do more. Mr. Storrow said that the priority board at Washington has refused to help New England and urged that a committee be appointed to present figures to the governmental authorities proving the immediate necessities of New England, and this was done. The committee holds itself in readiness to go to Washington for conference. The situation, it was declared, is worse than in the great coal strike of 1903.

"Gas and Flame" Thirtieth Engineers

Power has been called upon by the commanding officer of the Thirtieth Engineers to help in mobilizing the personnel of a "Gas and Flame" service regiment. This regiment is being recruited now from men volunteering for the service and will be ready to go "over there" by Thanksgiving. This is a regiment for skilled, practical men, who will be called upon at once to demonstrate their worth and skill.

Enlistment in the "Gas and Flame" Regiment offers opportunity to skilled men, to be used and recognized as men skilled in their trade. This opportunity should appeal to men who have previously felt that they were most needed at home because of their special training and experience.

The regiment will be required in the field of operation to supervise the American offensive; in "Gas and Flame" service and will be called upon to instruct men all along the front in this most important work. Consequently these men, all volunteers, will be in the thick of the greatest activities.

The Thirtieth is the pioneer regiment in the "Gas and Flame" service. Men who enlist now will be leaders in the spring offensive.

This organization will require a large proportion of men able to assume responsibility and to act upon their own initiative and individual judgment. There will be opportunities to advance to the higher noncommissioned grades. There will be opportunities for commissions.

The "Gas and Flame" service offers a real chance for red-blooded Americans to get in where their efforts will give definite results. In addition to needing any men who are looking for just this opportunity to help put across this important service, specialists are needed as follows:

Chemists (analytical, research and manufacturing), chemical workers, powdermen, men experienced in gas manufacture, machinists, automobile repair men, men able to operate and repair gas or steam engines, pipefitters, electricians, designers, interpreters, carpenters, blacksmiths, plumbers, boilermakers and chauffeurs. Men with long experience in their trades are especially desired to fill the master engineer grades.

All men enlisted in the Thirtieth must have good muscular development and be capable of undergoing active service at the front. Men are wanted who know how to take care of themselves, who are active, energetic and have a strong determination to carry out any mission to which they may be detailed.

Loyal American citizens with the foregoing qualifications, between 18 and 40 years of age, who have not actually been called by a local board in the draft, are eligible for enlistment.

The officers are specialists. Col. A. A. Fries, Engineers, N. A., is to be the commanding officer of the Thirtieth Engineers. He is a regular officer of the Corps of Engineers with many years' experience in military and civil engineering. He is now in France and is "Chief of the Gas Service."

Maj. E. J. Atkisson, Corps of Engineers, is organizing the first battalion of the Thirtieth Engineers at Camp American University, D. C. He is a graduate of West Point and of Cornell University.

All officers have been carefully selected from the Regular Army and from civil life, with a view to their special fitness for this particular service. They are experienced chemical, gas and military engineers.

Those desiring to enlist may go to the nearest recruiting station or United States District Engineering Office, state fully and clearly their qualifications and that they wish to be enlisted in the Thirtieth Regiment of Engineers (Gas and Flame). The officer in charge will examine applicants physically and pass upon their qualifications. If accepted, they will be enlisted and immediately sent to headquarters of the Thirtieth Regiment of Engineers at Camp American University, District of Columbia.

All men must first enlist as privates, the rate of pay being $33 per month and expenses. Men with the necessary experience may be assigned to special duties and given noncommissioned rank at rates of pay ranging from $40.20 to $96 per month and expenses. The latter include, for both privates and noncommissioned officers, food, clothing, medical attendance and transportation. Those who enlist will be eligible immediately for promotion, according to their ability and as openings occur. Men who enlist now will have excellent opportunities for promotion.

Negligent Practices Near Streets

Affirming judgment against the proprietor of a steam-power plant for injuries sustained by plaintiff through frightening a horse which she was driving along a public street by exhaust steam discharged from the plant through a pipe, there having been a sudden explosion of the exhaust, followed by a hissing sound, the Texas Court of Civil Appeals holds that defendant was properly held liable in damages on it appearing that reasonable care to prevent such accidents demanded that the exhaust pipe be constructed on the other side of the building or discharged into an excavation in the ground, which would have avoided frightening horses driven along near-by streets. (Scott vs. Shine, 194 Southwestern Reporter, 964.)

Information to Applicants for Enlisted Ordnance Corps

What It Is—The Enlisted Ordnance Corps, National Army, into which the Ordnance Enlisted Reserve Corps has been merged, is charged with the supply, maintenance and repair of all cannon and artillery vehicles and equipment; all machines for the service and maneuver of artillery; all small arms, ammunition, harness, motor trucks, motor cycles, tractors and railroad cars; in fact, it is the Army behind the Army commonly known as "Service of the Rear."

Type of Men Wanted—There is a place for practically every man who knows a trade in the Enlisted Ordnance Corps. Machinists, mechanics, plumbers, painters, carpenters, canvas workers, auto mechanics, saddlers, blacksmiths and wheelwrights are especially needed at this time.

Applicants must be between 18 and 40 years, citizens or declarants, and be able to speak, read and write the English language, should have no absolute dependents, and must be able to pass a physical examination conforming to that prescribed for the Regular Army.

Place and Type of Service—If accepted for enlistment, men will ordinarily be sent to an arsenal school for a period of instruction, on completion of which they will be assigned to detachments, units or organizations, with ultimate service abroad. Previous military training, while preferable, is not essential, as men will continue the work which they pursue in civil life.

Pay and Grade—In view of the importance of their work a large number of men will serve as noncommissioned officers. Original enlistment is required as private, but later courses of training or special qualifications quickly lead to higher grades. Pay ranges from $30 to $97.20 a month, depending upon demonstrated ability and place of service. Men enlist for duration of war only. Free quarters, rations, clothing, bedding, medical attendance, etc., are provided.

Relation to the Draft—Men registered under the Selective Service Law may voluntarily enlist prior to the posting of their names by their local boards. No man who has been called to appear for physical examination is eligible for enlistment in any branch of the military service. In case such men do enlist, the department under which they have enlisted will be requested to discharge them and direct them to report to their local boards.

How To Enlist—Get application blank by writing to Chief of Ordnance, Enlisted Personnel Division, Washington, D. C. Fill it out, return to Chief of Ordnance, and if there is an opening for you at the time, authorization will be sent you to enlist at the nearest recruiting station, and if accepted there, free transportation will be provided to place of service.

Men Wanted for Civilian Trades in the Army

The Quartermaster Enlisted Reserve Corps, with recruiting headquarters at 357 Broadway, New York City, have received a new authorization to enlist men to follow their civilian trades in the army, for duty in this country and abroad. The men particularly needed at this time are: Electricians, tinsmiths, iron workers, carpenters, plumbers, mechanics (auto), mechanics (general), masons, bricklayers, farriers, horseshoers, saddlers, blacksmiths, teamsters, cooks, chauffeurs, stenographers, wagonmasters.

Enlistment is open to citizens of the United States, or to those men who have declared their intentions of becoming citizens. They must be between the ages of 18 and 45 years and have no one depending on them for support. Men who can qualify for the positions named will be examined physically at recruiting headquarters, 357 Broadway, New York City, and immediately sworn into service, and will be given a week or more time in which to arrange their private affairs before being called for active service.

The enlistment in the Quartermaster Corps is for qualified men, and military training as a soldier is not required

in this branch of the service. They do not have to drill with rifles, perform guard duty or other purely military duties, except in cases of emergency.

You can be enlisted up to the time your notice to appear for physical examination is posted by your local board.

Applicants will be received at the Quartermaster Corps recruiting station, 357 Broadway, New York City, and the recruiting officer will be glad to give any further information on the subject of enlistment.

Backfire in Sawdust Furnace

On Oct. 17 a backfire from one of the boiler furnaces in the plant of the Columbia Box Co., 1900 North Market St., St. Louis, resulted in serious injury to two of the boiler-room hands, one of the men being so badly burned as to necessitate his removal to a hospital.

Factory refuse, consisting mainly of pine shavings and sawdust, is alone used as fuel in this plant. The refuse is blown to a large bunker over the boiler house, whence it is fed to the furnace of each of the two 450-hp. water-tube boilers through ducts connected to the middle of the furnace front. Provision is also made for hand-firing, through three doors in each front, from a supply of refuse dumped on the boiler-room floor.

The supposition is that with the stack damper nearly closed, fine sawdust had piled up almost to the top of the furnace, and that this was followed by a deluge of planer chips and shavings, which acted to blanket the mass of sawdust and thus prevent ignition of the gas that was being evolved. It is presumed that in this way the combustion chamber and passes of the boiler setting became clogged for the time being with gas that remained unconsumed for want of sufficient oxygen. When ignition finally did take place, there was an explosive combustion that shook the entire boiler structure, blew open the furnace doors and enveloped the two attendants in a sheet of flame.

Water Power in the United States

In a paper in the "Proceedings" of the American Institute of Electrical Engineers, C. W. Comstock gives some particulars of the present state and possible future development of water power in the United States. According to a report of the Commissioner of Corporations in 1912, the total amount of electrical power generated from water supply (including plants under construction up to June, 1911) was then about 6,000,000 hp. An addition of about 2,500,000 hp. might be made to include undeveloped power owned or controlled by concerns reporting developed power. The geographical distribution of water power is interesting. One-half of the population of the United States is east of the western boundary of the Ohio, and 60 per cent. of the developed water-power lies east of that meridian. On the other hand, there are curious anomalies. Thus, New England, which has only 8 per cent. of the hydro-electric power, has more than 40 per cent. of the manufacturing power. In many cases such discrepancies are due to local circumstances. Thus, on the Pacific the absence of coal (before the discovery of the oil supplies) led to water power being highly developed. Large as it may appear, the existing developed hydro-electric power is but a fraction of the total water power capable of development, estimated by the United States Geological Survey at about 200,000,000 hp. Future outlets for development require study. In the past the tendency has been to follow the demand for power, rather than to anticipate it. Electrometallurgical work is a profitable outlet. The author also considers that the commonly expressed view that the fixation of nitrogen from the air is commercially impracticable owing to the high cost of power is by no means proved to be correct.

The railroad connecting Chile and Bolivia, which crosses the Andes 14,105 ft. above sea level, provides oxygen chambers in which passengers can get relief from the rarefied air of the high altitudes.

New Publications

COMPRESSED AIR FOR THE METAL WORKER. By Charles A. Hirschberg. First edition, published by the Clark Book Co., New York, 1917. Size, 8 x 5 in.; 321 pp.; 294 illustrations. Price, $3 net.

A compilation of useful nontechnical information on current practice in compressed-air machinery, and the applications of compressed air, written especially for shop owners, superintendents and other users. While manufacturers' catalogs and bulletins, notably those of the Ingersoll-Rand Co., have been drawn on to a large extent for illustrations and tabular matter, this cannot be said to detract from the value of the book; rather, bearing in mind the intended fields, it may be considered an asset, as it brings the possible user in closer touch with commercial practice.

Among the subjects treated may be mentioned "The Compressed Air Power Plant," including a glossary of compressed-air terms; "Notes on the Selection of an Air Compressor," "The Classification of Air Compressors, and Tables of Sizes and Capacities," "Compressor Details," including air valves, intercoolers, steam valves and lubrication; "Accessories," including after-coolers, receivers, reheaters, and protective devices; "A Chapter on the Installation and Care of Compressors," and several chapters treating on the use of compressed air in the foundry, in sandblasting, in the machine shop, in the forge shop, for pumping and for cleaning.

AMERICAN HYDRO-ELECTRIC PRACTICE. By William P. Taylor and Daniel H. Braymer. First edition, published by McGraw-Hill Book Co., Inc., 239 West 39th St., New York, 1917. Size 6 x 9 in.; 439 pp.; illustrated. Price, $5 net.

This is more in the nature of a handbook based on the study of American practice as found in a number of representative plants, brief descriptions of which are included. In this the authors have drawn largely upon engineering journals, society papers and special bulletins. Although the greater part of the book is devoted to the electrical features, there is an introductory chapter on "General Survey of Water-Power Engineering," which includes a study of flow conditions, penstock losses, the selection of waterwheels, and numerous useful charts. Considerable space is devoted to cost figures, in which the authors have done well in not attempting to generalize; instead, the cost data have been classified according to location and special conditions. Other chapters include "Layout and Selection of Equipment," "Transmission Line Construction and Operation" including charts for calculating transmission lines, "Special Plant and Line Problems," and "System Operation and Economics."

The book will appeal alike to the designers and to the responsible operating men in hydro-electric plants.

AN ANEROID CALORIMETER FOR SPECIFIC AND LATENT HEATS

Scientific No. 301, of the Bureau of Standards, describes the construction and use of an aneroid calorimeter designed primarily for the measurement of the specific heats and the latent heats of a certain class of materials adapted for use in the production of artificial refrigeration. These materials include ammonia, carbon dioxide, sulphur dioxide, methyl chloride and ethyl chloride. At temperatures where the thermal properties are of importance to the engineer, the vapor pressures of these materials range from less than one atmosphere to over 70 atmospheres—15 to 1029 pounds.

The unstirred type of calorimeter has been embodied with important refinements in an instrument especially designed for determinations of specific heat and latent heat of refrigerating media. Heat developed and measured electrically is distributed automatically to the calorimeter, and contents, whose temperatures are measured by a platinum thermometer. Heat from other sources is excluded by a null method. The calorimeter is adapted for use between —50 deg. and +50 deg. C. in experiments where the measured heat added is used either to change the temperature of the contents or to evaporate a portion of the contents withdrawn as superheated vapor; in the first case the specific heat of the liquid, and in the second the latent heat of vaporization being obtained when proper correction is made. The experiments in the measurement of latent heat of vaporization and specific heat, between —50 and +50 deg. C., and for the pressures up to 70 atmospheres, are described in separate papers, paper No. 301 being devoted to the description of the instrument and its calibration.

Personals

J. A. Tenger has been appointed chief engineer of the Gold Street Station of the Brooklyn Edison Company.

S. S. Snyder has been appointed chief engineer of the Sixty-sixth Street Station of the Brooklyn Edison Co., succeeding G. E. Horton, who has been made inspector of construction of the company.

Eliott Greene has been appointed New England representative for the Steam Motors Co., of Springfield, Mass., with office at 1045 Oliver Building, Boston, Mass. He also represents the Harrison Safety Boiler Works, of Philadelphia, for the same territory.

Miscellaneous News

The Municipal Civil Service Commission has announced an examination for Inspector of Supplies and Repairs, Grade 3, for which applications will be received at Room 1400, Municipal Building, Manhattan, until Nov. 2, at 4 p.m. Citizens of the United States and residents of New York State are eligible. Candidates should have practical experience in the purchasing, storage, inspection or handling of supplies required in the city service; or experience in building construction and repairs; or related experience tending to qualify them for the duties of the position. Certification will be made from the eligible list to fill vacancies in the position of purchasing agent and fuel inspection within the compensation limits mentioned. The position pays a salary of from $1800 to $2400 per annum. For further particulars apply to the Municipal Civil Service Commission.

Trade Catalogs

Small Polyphase Induction Motors. Crocker-Wheeler Co., Ampere, N. J. Bulletin No. 182. Pages 4; 8 x 11 in.; illustrated. Describes this company's new line of two- and three-phase squirrel-cage type induction motors ranging in size from 0.5 to 3 horsepower.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Oct. 27, 1917	One Year Ago	Oct. 27, 1917	One Year Ago
Buckwheat ..	$4.98—5.20	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.40—4.65	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	.....	.....	.....	.....
Barley	3.90—4.15	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Prices per gross ton for Boston delivery are as follows:

	F.o.b. Mines*		Alongside Boston†	
	Oct. 27, 1917	One Year Ago	Oct. 27, 1917	One Year Ago
Clearfields ...	$2.42—3.47	$3.00	.....	$4.25—5.00
Cambrias and Somersets...	2.42—3.47	3.10—3.85	.....	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago; on cars Boston price is $8.50—8.75.
*All-rail rate to Boston is $2.69. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Oct. 27, 1917	One Year Ago	Oct. 27, 1917	One Year Ago
Buckwheat ..	$3.95—4.65	$2.75	$5.10—5.30	$4.25—4.50
Rice	3.40—3.60	2.20	3.80—4.10	3.00—3.25
Barley	2.90—3.15	1.95	3.00—3.30	2.10—2.25

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate).....	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Oct. 27, 1917	One Year Ago	Oct. 27, 1917	One Year Ago
Buckwheat ...	$2.90	$2.00	$3.80	$2.90
Rice	2.40	1.25	3.40	2.15
Boiler	2.20	1.10	3.30	2.00
Barley	1.90	1.00	2.15	1.00

Pittsburgh—Price of steam coal per net ton f.o.b. mine, Pittsburgh district:

	Oct. 27, 1917	One Year Ago
Slack	$3.00—3.25	$4.25—4.50
Mine-run	3.00—3.25	4.25—4.50
¾-in.	3.50—3.75	3.35—3.85

Add 40c. per ton for freight charge to Pittsburgh.

Chicago—Current prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Saline and Harrisburg	West Virginia Smokeless	Springfield	Clinton and Sullivan Counties
Steam lump ..	$2.20	$2.20	$2.40	$2.20	$2.20
Lump	2.30	2.30	2.40	2.20	2.20
Egg	2.30	2.30	2.40	2.20	2.20
Nut	2.30	2.30	....	2.20	2.20
No. 1 nut....	2.30	2.30	....	2.20	2.20
No. 2 nut....	2.30	2.30	....	2.20	2.20
No. 3 nut....	2.30	2.30	....	....	....
No. 1 washed.	2.30	2.30	....	....	....
No. 2 washed.	2.30	2.30	....	....	....
Mine-run	1.95	1.95	2.15	1.95	1.95
Screenings	1.70	1.70	1.90	1.75	1.70

Hocking lump, $2.60; splint lump, $2.40.

Northern Illinois thin vein—Prepared sizes, $2.65; mine-run, $2.40; screenings, $2.15.

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Oct. 27, 1917	One Year Ago	Oct. 27, 1917	One Year Ago	Oct. 27, 1917	One Year Ago
6-in. lump ..	$2.35	$3.00	$2.35*	$3.50	$2.35	$2.00
2-in. lump ..	2.35	....	2.35*	2.50	2.35	....
Steam egg...	2.35	....	2.35*	....	2.35	3.00
Mine-run ...	2.10	3.00	2.10*	....	2.10	2.75
No. 1 nut...	2.35	....	2.35*	....	2.35	....
2-in. screen..	1.85	3.00	1.85*	2.50	1.85	2.50
No. 5 washed	1.85	2.50	1.85*	....	1.85	....

*Strike.
Williamson-Franklin rate St. Louis, 72½c.; other rates, 57½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona....	2.15	2.40	1.90
Black Creek, Cahaba ...	2.40	2.65	2.15

Government figures.

[1]Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Idaho, Hailey—City Council plans to issue $90,000 bonds for the construction of an electric-lighting plant here. An election will be held about Nov. 15.

Mass., New Bedford—The J. C. Rhodes Co., 128 Front St., plans to build a new 20 x 40-ft. addition to its power house. Estimated cost, $10,000.

Mass., Palmer—(Official)—The Wright Wire Co., 69 Hammond St., Worcester, has retained Griggs & Myers, Engrs., 110 West 40th St., New York City, to prepare plans for the erection of a 12,000-kw. power station in connection with the new additions to its plant.

Minn., Wadena—The Village Council has plans under consideration for the erection of a distributing and a street-lighting system.

Miss., Lumberton—City has retained X. A. Kramer, Engr., Magnolia, to prepare plans for the proposed improvements to its power plant. A bond issue of $12,000 has been voted for the work.

N. J., Atlantic City—The Haddon Hall Hotel is having plans prepared by A. H. Savery, Arch., Stephen Girard Bldg., Philadelphia, for the erection of a new 1-story brick and concrete power house.

N. J., Camden—R. M. Hollinghead, 412 North 9th St., is having plans prepared for a new power house here.

N. J., Irvington—The Irvington Manufacturing Co., 124 Coit St., has been granted a permit to erect an addition to its power plant.

Neb., Pender—City rejected all bids received for electrical improvements. Estimated cost, $16,000. Henningson Eng. Co., Omaha, Engrs. Noted Oct. 7.

N. Y., Dunkirk—The Atlas Crucible Steel Co., Dunkirk, plans to build extensions to its plant, including the erection of a transformer station.

N. Y., New York—(Borough of Manhattan)—The New York Edison Co., 666 1st Ave., is having plans prepared for the construction of a new 1-story, 25 x 85-ft. addition to its power plant. Estimated cost, $7000.

N. Y., New York—(Borough of Richmond)—The S. S. White Dental Co., 5 Union Sq., New York City, plans to improve its power plant at Prince Bay. Estimated cost, $11,000.

N. D., Willow City—The Minot Electric Co. has been granted a franchise by the City Commission for the erection and operation of an electric-lighting plant here.

Ohio, Cleveland—The General Electric Co., 2242 Flournoy St., plans to erect a 1-story power house at its local plant. Estimated cost, $10,000. F. D. Chase, 122 South Michigan Ave., Arch.

Ohio, Columbus—The Trustees of the University of Ohio are in the market for coal-handling equipment, stoker for 600-hp. boiler and breeching. Noted Aug. 14.

Ore., Burns—E. T. Brussells, Burns, has applied to the City Council for a franchise to install and operate an electric-lighting system and power plant here.

Ore., The Dalles—City has had plans prepared by Malcolm Moody, Engr., The Dalles, for the erection of a large hydro-electric plant and dam on the Deschutes River near here.

Penn., Greensburg—Westmoreland County is having plans prepared by P. Bartholomew, Arch., for the erection of a new 55 x 65-ft. power house. Estimated cost, $30,000.

Penn., Philadelphia—A. Poth and Sons, Inc., 31st and Jefferson Sts., is having plans prepared by C. Casper, Arch., 925 Chestnut St., for the erection of a new 44 x 50-ft. boiler house. Estimated cost, $75,000.

Va., Cape Charles—Hickle Kellogg is having plans prepared for the erection of a 40 x 53-ft. power house here. Estimated cost, $10,000.

Ont., Alymer—(Official)—Town Council plans to purchase electrical transmission equipment, motor-driven pumps, etc. D. C. Davis, clk.

Ont., Fort William—Davidson, Smith & Co., Grain Exchange Bldg., is in the market for motors, shafting and general unloading machinery for a new grain elevator.

Ont., Mount Forest—T. H. Ellis, of Mount Forest, is in the market for a 5-hp., 220- or 550-volt, 60-cycle, single-phase motor.

Ont., Sarnia—McMillan & George, 198 Victoria St., N., are in the market for a "Kotten" or "Dallett" granite junior surfacer.

Ont., Tavistock—The Tavistock Milling Co., Maria St., is in the market for a 25- or 30-hp. boiler for heating purposes.

Que., Granby—The Southern Canada Power Co., of Drummondsville, 43 St. Francis Xavier St., Montreal, has been granted a franchise for the erection of a substation here. W. B. Blockley, Drummondsville, Engr.